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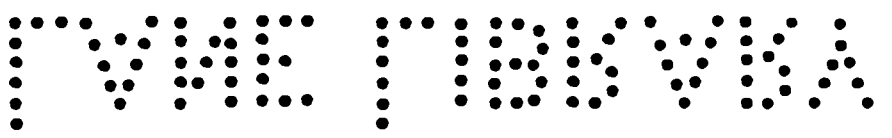

THIRTY-THIRD ANNUAL REPORT

OF

Gt. Brit.

THE LOCAL GOVERNMENT BOARD,

1903–04.

SUPPLEMENT

CONTAINING THE

REPORT OF THE MEDICAL OFFICER

For 1903–04.

Presented to both Houses of Parliament by Command of His Majesty.

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ANNUAL REPORT

OF THE

MEDICAL OFFICER

OF

THE LOCAL GOVERNMENT BOARD

FOR THE YEAR

1903-04.

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REPORT.

MEDICAL OFFICER'S REPORT.

TO THE RIGHT HONOURABLE GERALD W. BALFOUR, M.P., PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

SIR,

I HAVE the honour to submit a record of the work carried on in the Board's Medical Department in 1903-04.

The personnel of the Department has remained unchanged save for, during a portion of the year, appointment of Dr. John Spencer Low as Temporary Inspector in the place of Dr. Theodore Thomson, detached from the staff on special duty.

INTERNATIONAL AND IMPERIAL SERVICE BY THE MEDICAL DEPARTMENT.

INTERNATIONAL CONVENTI

The International Sanitary Conference of Paris, 1903, which assembled on the 10th October of that year, remained in Session near upon two months, and as a result formulated the new International Sanitary Convention now awaiting ratification by the several Signatory Powers. The British representatives at this Conference were Mr. M. W. E. de Bunsen, C.V.O., C.B., Secretary of His Majesty's Embassy in Paris; Dr. Theodore Thomson, one of the Medical Inspectors of the Board; Dr. F. G. Clemow, British Delegate to the Constantinople Board of Health; and Mr. A. D. Alban, His Majesty's Consul at Cairo. British India was represented by Surgeon-Colonel J. Richardson.

Assembly of the Paris Conference was in the main due to growing demand for international recognition of concern of the rat in dissemination of Plague, with a view to agreement as to measures suitable for safeguarding the Public Health against such danger as might be found referable to this source of the disease. Further, however, it was generally considered that the time had come for co-ordinating in a single International Convention the principles embodied in the several Conventions of 1897, 1894, 1893, and 1892; and this for the reason especially that some of the provisions of the Conventions in question were not free from obscurity of meaning, while particular measures prescribed by them could be represented as even in conflict.

MEDICAL OFFICER'S REPORT.

The report presented to the Marquess of Lansdowne by the representatives of Great Britain and British India at this Conference is reproduced in Appendix A, No. 1. This report gives, in summary form, an account of the proceedings of the Conference and of the more important decisions arrived at. Also it records that questions other than those which immediately determined the occasion of the Conference obtained careful consideration: in particular, the incubation period of plague; articles hitherto deemed "susceptible"; the constitution of the Constantinople Board of Health; Sanitary Measures in the Red Sea, Suez Canal, and Persian Gulf; and proposals for establishment of an International Health Bureau.

Considered as a whole, the Convention which is the outcome of the labours of the Conference, may justly be regarded as marking a distinct advance, in the sense of greater breadth of view, among the nations in the matter of public health questions involving international obligation. Nevertheless it is to be regretted that diversities of opinion on the rat question among members of the Conference could not be reconciled to the extent of obtaining security that measures of rat destruction on board ship should in no case be applied needlessly. In this matter the British Delegates had finally to rest content with less relaxation of proposed stringency than they pressed for, in the hope that at some future international conference delegates of other countries may be found to have modified their views on this question in a direction more in accord with those expressed in 1903 by their colleagues from this country.

In the above connexion it is interesting to note that the tendency aforetime exhibited by foreign countries to accept at later Conference British views which at earlier International meetings had been put forward without success, was a conspicuous feature of the Conference with which I am now dealing. Especially was this disposition noteworthy in 1903 in relation with questions arising as to the incubation period of plague, as to "susceptible articles," and as to licence for medical inspection by night as well as by day of vessels passing through the Suez Canal. Recognition of a shorter period than ten days as the incubation period of plague, and ability to medically inspect by night vessels passing through the Suez Canal provided they were adequately lighted, matters which were unsuccessfully pressed by the late Sir Richard Thorne on behalf of Great Britain at the Venice Conference of 1897, have found approval at the Paris Conference of 1903, and have accordingly been duly embodied in Convention. In like manner British protests, hitherto of small avail, against the principle involved in the phrase "susceptible" articles, the long list of such articles, and the treatment to which they were inconveniently liable, have at last met with a large measure of success.

MEDICAL OFFICER'S REPORT.

The Paris Convention of 1903 may indeed be regarded as having in greater degree than any previous International Sanitary Convention, attained that combination of due and sufficient regard for public health with removal at the same time of unnecessary restrictions on commerce which it has always been the object of Great Britain to secure. The Convention has also considerable merit in that it gives us in the place of four occasionally obscure and even conflicting documents, a single instrument which is simple in arrangement and free from contradictory provisions.

COLONIAL "QUARANTINE" REGULATIONS.

In June, 1903, the Secretary of State for the Colonies addressed a communication to the Board asking that your predecessor would place at his disposal the services of an officer of the Department for advisory purposes on the occasion of a Conference of Colonies at Barbados on the subject of "Quarantine" Regulations.

In the West Indies, it appeared, regulations of this class by reason of want of uniformity in the measures prescribed by the several Colonies and in particular on account of their stringency, had been giving rise to serious inconvenience and loss to the travelling public and to commerce. Accordingly the object of the proposed Conference was to secure harmony between the Regulations of the Colonies concerned, while at the same time substituting for certain of the existing maritime restrictions precautionary measures of different nature.

Your predecessor regarded it as essential to attainment of the object of the Conference that the Board's representative should, as a preliminary, visit the several Colonies in question, and make himself acquainted with the local conditions and administrative circumstances of each of them. The West Indian Colonies, having been advised to the effect, expressed each their concurrence; whereupon the Board placed the services of Dr. Theodore Thomson at the disposal of the Secretary of State for the Colonies, with a view to his making the visits that had been determined on and to his attending subsequently at the proposed Conference. Fulfilment of these duties occupied Dr. Thomson during the first five months of 1904.

OTHER SUPPLEMENTAL DEPARTMENTAL BUSINESS.

Your Medical Officer has continued to serve on the Royal Commission on Sewage Disposal, and has remained a member of the General Medical Council. As heretofore he has advised on public health questions affecting this country's dependencies and colonies which have been referred to the Board by the Foreign Office and by the Colonial Office; and similarly he has been consulted respecting legislative measures contemplated by the Privy Council and having bearing directly or indirectly on health questions.

During the year 1903 Dr Parsons again served as the Board's representative on the Committee of Advice on the Geo-

MEDICAL OFFICER'S REPORT.

logical Survey, appointed by the President of the Board of Education. The Committee reported that good progress was being made in the work of the Survey; and among other recommendations advised that the records of well-borings and other information in the possession of the Survey relating to the underground water supply of different counties should be published in a form available for local authorities and others, and that the memoir on the underground water supply of Lincolnshire, which was in preparation, should be followed by similar memoirs upon other counties, among which, in the first instance, Northamptonshire, Kent, and Suffolk were mentioned The Director of the Geological Survey expressed a desire that, for the purpose of these memoirs, the Board should furnish him with such information as to well sections, yield of wells, and quality of water as might come into their possession in connection with schemes of water supply. The Board agreed to afford the Survey such information as they could properly supply, and the Engineering Department have prepared, with the assistance of this Department, a form for recording the particulars desired, with a view that a copy shall in each instance be sent to the Geological Survey.

Early in 1903 the Army Council, at the instance of the Advisory Board for Army Medical Services, appointed a small committee "to direct a course of investigation into the practical prophylactic and therapeutic value of current methods of immunisation against enteric fever"; and the Board was invited, through the Director-General of the Army Medical Department, to nominate a member of their Medical Staff for service on the Committee in question. To this the Board assented, selecting Dr Bruce Low for the duty. Dr Low has accordingly taken part in the work of the Committee, which has not yet completed its labours

Dr. Buchanan continued to serve as Secretary to the Royal Commission on Arsenical Poisoning until January, 1904, the date at which the Commission issued their final report.

This Commission was appointed, at the instance of your predecessor, in February, 1901. After investigating the circumstances of the epidemic caused by arsenic in beer, by which over 6,000 persons in the North-Western and Midland Counties had suffered during 1900, the Commission undertook an elaborate study of the liability of articles of food and drink other than beer to contain arsenic, as a result of ignorance or carelessness on the part of those concerned in their preparation. Their inquiries had furnished valuable additions to our knowledge, not only in these matters, but also in regard of the deleterious effects of continued ingestion of minute quantities of arsenic along with food. A further study by this Commission, of administrative questions which arise in connexion with the contamination of food by deleterious substances, and

as to the nature of the public control over purity of food which is at present exercised under the Sale of Food and Drugs Acts and other Acts, resulted in a series of recommendations, contained in the Commission's final report, which are receiving, along with the Report of the Food Preservatives Committee, the Board's careful consideration. The special knowledge which Dr. Buchanan acquired during his work for the Commission has proved of much service to the Medical Department, which is being called upon to advise the Board in a variety of questions relating to purity of food and administration in regard thereto.

General Administrative Business of the Medical Department.

Information and experience in matters relating to public health have continued to be interchanged, as before by personal conferences, with officers of other Departments of Government and with representatives of various authorities and public bodies at home and abroad: to the considerable advantage, as is believed, of the several parties concerned. Conferences have been held at this office with local authorities and their officers on a variety of subjects—such as hospital construction, local bye-laws, appointment of officials—in their technical and administrative aspects. Conferences have also taken place between Medical Inspectors and local authorities and their officers on like matters within the districts actually concerned. The Board's custom of thus placing at the disposal of local administrative bodies experience and information in possession of the Central Authority has, it is believed, proved useful and acceptable to authorities and their officers. Exercise in this way of the advisory functions of the Board has again, though to much less extent than in the previous year, had particular concern with the control of small-pox. On the other hand, formal inquiries by Medical Inspectors into such matters as combination of districts for hospital purposes, loans for hospital sites and buildings, proposals as to local bye-laws, and schemes for water supply and sewage disposal, have been especially numerous. As in other years a Medical Inspector has, in particular instances, been associated with officers of other Departments of the Board for the purpose of joint investigation.

A summary of the total work of the Medical Inspectors is given in Appendix A, No. 2, and in Appendix A, No. 3, will be found abstracts of the several detailed inquiries undertaken by Medical Inspectors on account of outbreaks of infectious disease, or of defective administration. Certain of the reports of Inspectors on the above matters, which for one or other reason are of particular interest, are reproduced in Appendix A, Nos. 4 to 8.

The town of Bedford since 1871 has obtained its supply of water by pumping, at a well by the side of the Ouse, just above Bedford, from headings driven into the Great Oolite limestone. In the neighbourhood of Bedford this limestone is comparatively thin; it comes to the surface only in relatively small areas near to the river, being elsewhere covered by a series of impervious strata. The growing demands of Bedford have necessitated extensions of the "headings" from time to time, and extra demand has occasionally led to the supply being supplemented by water taken directly from the Ouse. Some four years ago, when the Bedford Town Council took stock of the position, they were advised that their existing works were in many respects inadequate; that it was doubtful whether further headings, if constructed, would supply water enough for the needs of the near future; and that certain opportunities for serious pollution of water derived from the headings had arisen. As a result a far more efficient system of filtration was called for. Thereupon the Town Council decided to abandon the local Oolite water, and to go, some 12 miles south of Bedford, to the Lower Greensand, where there is every reason to believe that an abundance of water can be obtained by pumping from deep wells. For this purpose the Town Council, in 1902, sought and obtained the necessary Parliamentary powers (including ability to borrow sums not exceeding £135,000, repayable in 60 years), and in connexion with the proposed Greensand scheme they spent some £3,000 in preliminary expenses. The Town Council then changed their attitude, and in 1903 resolved to abandon the Greensand scheme, and instead to increase their existing water works, taking measures to prevent pollution of the supply and to secure better filtration. They applied to the Board for sanction to borrow £24,000, which was reckoned to be sufficient to secure a satisfactory supply in this way from the Great Oolite. In February, 1904, formal inquiry into this application was held by Mr. H. R. Hooper, of the Board's Engineering Department, and Dr. Buchanan. Their report, made in March, 1904 (Appendix A, No. 4) has been included in this volume, partly for its local interest, but mainly in anticipation that it will be useful to local authorities and their advisers who may also be confronted with the necessity of choosing between making radical alterations in an existing system of water supply and providing new water works altogether. The report derives a further interest from the intricacy of the geological and other problems with which the inspectors were called upon to deal, and from the consideration given to a somewhat novel method of sand filtration in which the Bedford Town Council are still experimenting.

In brief, the inspectors concluded that, looking to all the circumstances, especially to the requirements of this growing town in the near future, Bedford cannot hope to obtain a supply

adequate in quantity and satisfactory in quality by the expenditure of £24,000 in the manner proposed. They advised, however, that it would be possible to obtain such a supply from the Oolite by developing the existing water works, if additional precautions were taken to guard against pollution, if further work were undertaken to secure uniform and satisfactory filtration, and if also a number of additional engineering works were provided. The matters are formulated in detail in their report. In these circumstances, it was evident that adoption of an Oolite scheme must needs entail considerably greater expense than the Bedford Town Council appeared to anticipate, and the Board accordingly informed the Town Council of the inspectors' conclusions, and advised reconsideration on this new basis of the relative merits and costs of a satisfactory Oolite scheme on the one hand and of the Greensand scheme, authorised by Parliament, on the other. MEDICAL OFFICER'S REPORT.

Notwithstanding the steady sanitary progress which is taking place in the country as a whole, it not rarely happens that instances come under the notice of the Board of conspicuous failure on the part of local sanitary authorities to appreciate the responsibilities and duties which Parliament has devolved upon them. In Appendix A, No. 5, is a report by Dr. Reece, which serves, more particularly in certain directions, to illustrate failure in the above sense, while raising question as to the determining influences which saddle sanitary authorities with persons, whether as "councillors" or as "officers," destitute of knowledge and of desire for knowledge of sanitary matters. LOCAL MA... ADMINISTRA... TION.

The Spennymoor Urban District is situated in the County of Durham, and contains a population of some 17,000 persons engaged for the most part in mining This district, which has from time to time during many years come under the notice of the Board through reports of their Medical Inspectors on account of defective local sanitary administration, has proved equally unsatisfactory from the point of view of the administrative county of which it forms a part. In 1901 and 1902 the Durham County Council made formal complaint that the District Council in question had failed to carry out their obligations under the Public Health Act, 1875, and that the death rates, general and special, of the district were abnormally high. Dr. Reece was accordingly instructed by the Board to make local inquiry into the matter: and his report goes far to justify the strictures of the County Council. He notes: that the death rates of Spennymoor stand out prominently at disadvantage compared with like mortality records for the country generally; that opportunities for soil and subsoil pollution abound in consequence of the ubiquity of the midden-privy system; that back streets are badly scavenged; that sewers are neither sufficiently ventilated nor flushed, and that they are, some of them, badly constructed, besides being

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for the most part jointed in clay; that though the sewage admittedly is discharged by several separate outlets to tributaries of the Wear, the position of some of these outlets was not known to the District Surveyor In this connexion, Dr. Reece, referring particularly to Spennymoor Ward, reports that, notwithstanding works provided for purification of the sewage of this portion of the district, it is no uncommon practice to liberate such sewage "untreated" into a brook, this being done by way of a bye-pass which obtains no recognition whatever on a plan of these sewage works specially prepared for him by the Surveyor. To summarise in the words of the Inspector the result of sanitary shortcomings in Spennymoor:—"It is impossible to go far in the inhabited part of this district without coming upon obvious nuisance." In the circumstances, it is not surprising that the whole time of the inspector of nuisances is regarded by Dr. Reece as being demanded to supervise mere cleansing operations; and that as a consequence none of the common lodging houses in the district comply with the Council's own byelaws; that cowsheds are nearly all in dirty condition: and that the slaughter houses of the place call for systematic inspection.

Not least unsatisfactory in Dr Reece's account of Spennymoor is what he has to say respecting the attitude of this District Council in the matter of selecting and appointing executive officers: a clue, perhaps, to the maladministration to which he bears testimony Thus, on occurrence shortly before Dr. Reece's visit of a vacancy in the post of inspector of nuisances, the authority having been called on to select a successor to the office from among 123 candidates, 82 of whom possessed certificates of competency in sanitary matters, chose as inspector a member of their own body and chairman of their works committee. This individual, a miner aged 38 years, did not possess a certificate of competency and seemingly had not had experience in a sanitary executive capacity. It is hardly necessary to add that the Local Government Board declined to sanction this appointment.

Formerly the Spennymoor Medical Officer of Health received a salary of £100; but on appointment of the present holder of the office this sum was reduced by the District Council to £75, on the score of less work to do in the district than formerly In view, perhaps, of this consideration, the Medical Officer of Health has recently been appointed Medical Superintendent at the Isolation Hospital; for which service, which includes, with control of the hospital, attendance on the patients therein and provision of their medicines, it was in contemplation at the date of Dr. Reece's visit to remunerate the officer at the rate of 1s. 1¼d per day throughout the year.

Despite discouragement in the sense above indicated, this Spennymoor Medical Officer of Health has, Dr. Reece states,

rendered good services to his authority; but "unfortunately the Council have not always taken advantage of the reports of their Medical Officer of Health." MEDICAL OFFICER'S REPORT.

In bringing his report to a conclusion, Dr. Reece records certain facts respecting death registration at Spennymoor which add force to the representations already submitted by your Medical Officer as to the need, at any rate in certain districts of the country, for strict investigation by the Health Authority of "uncertified" deaths, particularly those of children. Spennymoor is, it appears, pre-eminent in Durham for high birth rate, for high infantile mortality, and, above all, for the large proportion (more than 24 per cent.) of its deaths not medically certified. Further, it appears that the bulk, two-thirds that is, of this "uncertified" mortality is furnished by deaths of children under 5 years of age. These defects of local death registration in their statistical and public health aspects had, before the date of Dr. Reece's visit to Spennymoor, formed the subject of correspondence between local authorities and their officers and the Registrar-General, but, as will be seen from the addendum to Dr. Reece's report, without satisfactory result. It is greatly to be desired that legislation giving power to the medical advisers of local authorities to make prompt inquiry in each instance in the matter of uncertified deaths be undertaken as soon as opportunity offers.

So far as time at the disposal of the Medical Department admits attention is being given, through the Inspectors, to districts which shew, by their statistical returns and by annual reports of their Medical Officers of Health, persistence in undue amount of enteric fever. In this way the Board are seeking to determine conditions common to such districts, amelioration of which may be confidently associated with observed diminution of fever prevalence. ENTERIC FEVER AT TYLDESLEY-WITH-SHAKERLEY

The Urban District of Tyldesley-with-Shakerley is a district of the class in question, and Dr. Johnstone was instructed to visit it with a view to ascertaining what were the conditions capable of removal with which enteric fever might, more particularly in 1901, be regarded as having been associated. As will be seen from tables furnished in Dr. Johnstone's report (Appendix A, No. 6), the enteric fever death rate of the district for the period 1892-1901 was more than double that of England and Wales, and was in excess also of the "fever" rate of his 33 great towns. Dr. Johnstone was unable as a result of his investigation to attach importance to food, milk, or water as having been operative in maintaining enteric fever in Tyldesley through 1901 or in previous years, nor was he able to lend support to the view, which was locally entertained, that this disease had been spread among persons employed underground in the coal mines by means of infected dust distributed through

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MEDICAL OFFICER'S REPORT.

the "workings" by the ventilation arrangements adopted. It would appear, indeed, from Dr. Johnstone's observations, that these miners suffered rather less than more from enteric fever than other inhabitants of the district.

The particular circumstance to which the inspector was inclined to attach importance as having had perhaps main concern in maintenance of the enteric fever was a general fouling of the soil and subsoil in the neighbourhood of dwellings as a result of defectively paved or unpaved yards and by means of the privy middens which abound in the district. In this connexion—*i.e.*, as regards retention of excremental matters in the neighbourhood of dwellings—Dr. Johnstone was disposed to regard with suspicion a number of waste water-closets which have been established in the district owing to refusal of the District Council to supply water free of charge for closet flushing purposes. He found the descending tube of these closets nearly always much fouled with stale excrement.

Once more therefore there is afforded, in this report of Dr. Johnstone, indication of association of prevalent excremental nuisance and persistence of enteric fever; and once again there follows the inference that as regards districts notable for undue endemicity of enteric fever their District Councils will not have done all in their power to reduce prevalence of that disease until they have got rid of the obviously unwholesome conditions with which this disease has been so constantly associated.

EPIDEMIC SKIN DISEASE.

From time to time during recent years there have occurred in several of the Metropolitan Poor Law Infirmaries extensive outbreaks of anomalous skin-disease, attended, some of them, by considerable mortality. For the most part these outbreaks have been observed in the warmer months of the year, and mainly they have affected persons of advanced age, especially persons suffering from chronic and debilitating disease.

The first outbreak of this nature to which attention was drawn in this country occurred in 1891, when cases of the skin malady were observed and fully described by Dr. T. O. Savill in relation with the Paddington and St. Marylebone Infirmaries. The disease at that time was termed "epidemic eczema"; but later, owing to the fact that the symptoms did not always conform to an eczematous type, it became known by the vague term "epidemic skin disease." The malady, it would seem, presents itself under a plurality of forms, though as a general rule its varieties are either "moist" or "dry." In the more severe cases a considerable rise of body temperature has been noted, more particularly in some outbreaks, and commonly the cutaneous eruption has had associated with it marked irritability and itching. Desquamation, which is practically a constant feature, ranges from mere casting off of powdery scales to shedding of the entire cuticle from the regions of the body that are affected.

The etiology of this skin disease cannot yet be said to have been fully elucidated. Nevertheless it is a remarkable fact that in well-nigh all the outbreaks that have come under observation suspicion has fallen on milk as concerned with the malady. In most, however, of the past outbreaks the case against milk has lacked cogency from the fact that nothing seriously abnormal could be detected in the suspected milk, although routine testings, perhaps, showed that it was of poor quality. But it has to be observed that in previous investigations particular scrutiny of the milk was limited to attempt to detect in it micro-organisms which could be thought of as causing this malady, or to discovery of some inferiority of the milk, chemically or biologically. On one previous occasion only has implicated milk been tested as to presence in it of chemical preservative; and in that case boric acid was detected.

In a recent outbreak at Hendon, investigated by Dr. Copeman (Appendix A, No. 7), the skin malady was without doubt of similar sort with that observed at other Poor Law Institutions which have similarly come under notice. The type of the malady was, however, on this occasion mild, a circumstance which led to the earlier cases being overlooked. As before, persons of advanced age and suffering from chronic ailments were the chief sufferers by the skin malady; and here again suspicion fell at once on the milk supply of the institution. Further, it appeared all but certain that the milk purveyor to this institution had in the past, albeit under another name or names, supplied milk to other Poor Law Infirmaries in which this skin malady had manifested itself.

Dr. Copeman inquired carefully as to a number of conditions that might possibly have operated in bringing about the outbreak. He was able, as in other outbreaks of like kind, to exclude mechanical or chemical causes directly affecting the skins of the sufferers, such as coarse or dyed bedding, or body linen; and he satisfied himself that personal infection had borne no material part in disseminating the malady. In this instance, moreover, the sanitary circumstances of the building were, it appears, all that could be desired in an institution of the sort in question. As regards dietary, Dr. Copeman was able to reduce the articles of food consumed in common by all the persons attacked to three, namely, bread, butter, and milk. Concerning the first two of these, he could obtain no evidence tending to suspicion of their wholesomeness; whereas as regards milk the facts were altogether consistent with this article of food having served as the medium by which the cause of the disease had operated. In this connexion it deserves notice that, as has happened in other "milk-outbreaks," recognition outside the institution of the fact that the particular milk had come under grave suspicion had been followed by early cessation of fresh attacks among inmates of the asylum.

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The milk here in question had, it appears, been as matter of routine tested twice daily in regard of the percentage of cream contained in it, and the steward, who applied these tests, observed during exceptionally warm weather that particular samples of the milk remained "good" and uncoagulated for as long a time as three or four days. This behaviour of the milk naturally raised strong presumption that some preservative had been added in extra liberal quantity to the bulk of milk whence the particular samples were derived. It is not, however, to be inferred that the milk supply of the institution was habitually doctored to the extent above indicated. Probably such fortifying of the milk was exceptional. Indeed, a few weeks later, while the contractor was under notice as to determination of his contract, certain deliveries of his milk at the institution were rejected for the reason that on arrival there they were found to be sour. Nevertheless samples of this purveyor's milk examined, at Dr. Copeman's instance, by Dr. Wilson Hake shortly before supply of the institution from this source came to an end, yielded in every instance evidence of the presence in the milk of formalin.

Formalin, which is a 40 per cent. solution of formic aldehyde, is a well known powerful preservative. But it possesses the disadvantage of retarding or even preventing altogether pancreatic digestion, and further by its tendency to combine with the proteids of milk is apt to form in that fluid insoluble compounds, thus lowering the digestive value of the milk and perhaps conferring on it irritative property. In these aspects formalin was regarded by the Departmental Committee appointed to inquire into the use of Preservatives and Colouring matters in Foods as a danger to health, and accordingly that Committee recommended that the use of this substance in the preparation of foods and drinks should be absolutely prohibited.

)USING IN HITEHAVEN.

The Town Council of Whitehaven having, in consequence of an outbreak of enteric fever in that borough in 1901, sought aid from the Board, Dr. Bulstrode was instructed to make investigation of the circumstances of the fever and to report thereon. An account of this outbreak and of the conditions with which it was associated is given in the report of your Medical Officer for 1901-02, and attention is there drawn to the eminently unsatisfactory conditions under which the working classes of Whitehaven are housed owing to the unregulated erection of dwellings upon every available space within the town.

On the receipt of Dr. Bulstrode's report the Town Council appointed, it appears, a sub-committee to consider it, which committee delegated two of their members to make detailed inspection of the borough. As a result a report was made by the sub-committee, and certain improvements on the lines suggested by Dr. Bulstrode were carried out. It remained, however, doubtful how far the measures that were being adopted

were likely to mitigate the exceptionally unfavourable housing conditions described by Dr. Bulstrode, and accordingly the Board determined on re-inspection of Whitehaven, Dr. Reginald Farrar being entrusted with this duty.

Dr. Farrar, whose report on Whitehaven is reproduced in Appendix A, No. 8, found that much good work had been carried out by the Town Council in view of the facts brought under their notice in Dr. Bulstrode's report; indeed, perusal of Dr. Farrar's report suffices to show that considerable advance had been made in sanitary administration of the borough. It was, however, necessarily to the housing of the working classes in Whitehaven that Dr. Farrar paid special attention; and in this particular he found that the conditions described by Dr. Bulstrode remained practicaly unchanged. The remarkable overcrowding of dwellings on area to which attention was drawn in your Medical Officer's report for 1901-02 is thus described by Dr. Farrar:—

> "Opening out of the main streets are a succession of squalid alleys and courts approached by passages, which are less than three feet in width. These passages lead to networks of tenements in back-to-back houses, the occupants of which are in gloom the whole year round."
>
> "Hardly a single house in the courts has any through ventilation. Those that are not back-to-back are built against dead walls of larger houses, or against the cliff face. A very large proportion of these tenements face a blank wall less than three feet from their front, or look into their neighbour's windows from a similar distance. Of the 166 courts and alleys enumerated in the sub-committee's report I personally inspected 150, and in more than 120 I noted obstructive houses or blocks. Some of the worst have been closed; others have been unoccupied for years; the closing of others is recommended by the sub-committee."

It is obvious therefore that little has been effected in remedy of the exceptionally unfavourable housing conditions in Whitehaven. Locally, indeed, it is urged that were all obstructive and badly lighted and badly ventilated dwellings in the town closed, as the Whitehaven Medical Officer of Health is understood to consider necessary, much overcrowding of other parts of the district would necessarily result. There is probably truth in such contention, and the greater reason, therefore, for speedy erection of wholesome dwellings outside the present town limits. Until action in this sense is undertaken, no valid improvement of housing conditions in Whitehaven will have been effected. For as Dr. Farrar observed:—

> "The squalor, moral, physical and social, which at present exists in the slums of Whitehaven has not been effectively diminished by the work done; for the condition of the

town is such that no measure short of an effective scheme of demolition and the provision of additional house accommodation on suitable sites beyond the area at present inhabited will be of permanent benefit."

The story of Whitehaven, as told by Drs. Bulstrode and Farrar, is no doubt one fraught with many instructive lessons. Chief among these is the importance of preventing recurrence of building mistakes in future; a lesson, indeed, of which heed should be taken throughout the country.

The Commissioners of H.M. Customs, in view of the Report of a Departmental Committee on the Customs arrangements for boarding vessels coming from abroad, made representation to the Local Government Board that routine official challenge of such vessels before their arrival at the dockhead, hitherto practised, might conveniently be dispensed with, to the considerable advantage of the shipping trade and without detriment to the Imperial Revenue. The Board have accordingly had under consideration how far relaxation of the present method of Customs procedure in regard of vessels of the class in question may be deemed compatible with due safeguarding of England and Wales against importation of exotic disease; and in this connexion Dr. Reece has visited a number of our Port Sanitary Districts, conferring in each instance with the local officials concerned. A decision on this somewhat complex matter had not, by the end of the year, been arrived at.

Sanitary Authorities of certain towns where excrement disposal has been on a "dry" system have obtained from Parliament powers enabling them, under conditions, to obtain substitution of a water carriage system for the privy midden, pail closet, or other dry method which has been found objectionable, and applications are now and again made to the Board for powers under Section 303 of the Public Health Act, 1875, with a like object. In the circumstances the Board have deemed it necessary to obtain information in detail from towns administering local Acts of the nature indicated as to the success or otherwise of the measures adopted. Dr. Darra Mair, Dr. Johnstone, and Dr. Manby have accordingly visited West Bromwich, Sunderland, and Stockport, and have reported fully to the Board on the subject.

Application having been made to the Board by the London and India Dock Company for issue of an order enlarging, in the matter of unsound food, the jurisdiction of the London Port Sanitary Authority so as to embrace *all* wharves in the Thames at which food stuffs are landed, the Board directed Dr. Theodore Thomson to hold a public local inquiry into the matter. It was the contention of the London and India Dock Company that the examination of imported food stuffs practised by the London Port Sanitary Authority was altogether more complete and thorough than that carried out at riverside wharves by the

several riparian Metropolitan Borough Councils, and that the interests of the Dock Company were suffering in consequence of want of uniformity of procedure. The Board have not seen their way to dealing with the question raised by the Dock Company by issue of an Order of the kind applied for.

Dr. Bulstrode has, from time to time as opportunity offered, visited and collected information respecting a number of the Phthisis Sanatoria lately established in England and Wales; and he has continued his observation of the Shellfish Industry of the Country in its public health aspects.

Dr. Buchanan, in concert with representatives of the War Department, has investigated and advised that Department respecting alleged pollution of a tributary of the River Lea, through the operations of the Royal Gunpowder Factory at Waltham Abbey.

Mr. Huddart, in aid of your Medical Officer in exercise of his advisory functions, has continued his investigations of the conditions of employment and remuneration of Inspectors of Nuisances and other non-professional executive officers.

In Appendix A, No. 9, will be found the Memorandum and Circulars relating to Public Health and Vaccination prepared or revised in the Medical Department during 1903. These were:—

A. MEMORANDUM:—

Memorandum on the Circumstances under which the Closing of Public Elementary Schools or the Exclusion therefrom of particular Children may be required in order to prevent the Spread of Disease.

B. CIRCULARS:—

(1) Vaccination Acts, 1867 to 1898. Recovery of Penalties. To Boards of Guardians in the Metropolis. (28th January, 1903.)

(2) Small-pox. Casual Paupers. To Extra Metropolitan Boards of Guardians. (9th February, 1903.)

(3) Midwives Act, 1902. To County Councils and Town Councils of County Boroughs enclosing memorandum on the Act. (27th April, 1903.)

(4) Disused Army Blankets imported from South Africa suspected as being specifically infected by discharges from enteric fever patients. To certain Town and District Councils. (25th May, 1903.)

Of the above circulars, that concerning possibly infected blankets returned from South Africa and distributed in various parts of this country relates to a matter of unusual interest. Attention was first directed to the blankets in question by the Assistant Port Medical Officer of Health of London, Mr.

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Hancock, who referred an outbreak of enteric fever on board the training ship "Cornwall" to use by the boys of dirty and stained blankets, some of which had, when tested by Dr. Klein, afforded evidence of specific contamination. Mr. Hancock having ascertained that these blankets, though purchased from a firm in the City, were reputedly from a South African source, at once communicated with Dr. Collingridge, Medical Officer of Health of the City of London, who forthwith not only took steps to stop further sale, until disinfected, of the South African blankets still remaining with the firm in question, but also set to work to ascertain the various districts throughout the country to which the implicated blankets had been distributed, along with the names and addresses of the retail dealers who had received consignments of such blankets. Thus aided the Board were enabled to issue direct and prompt warning to these districts.

The districts were numerous, and situated in all parts of England and Wales. As a result of action by the different medical officers of health nearly all the implicated blankets were traced. Some were returned by the retail shops to the wholesale dealers, others were either destroyed or thoroughly disinfected.

VACCINATION AND PUBLIC VACCINATION.

INSPECTION OF VACCINATION

The number of Unions inspected in 1903 in regard of Vaccination amounted to 246, comprising 1,298 Public Vaccinators' districts. The Public Vaccinators of 815 of these districts were recommended for Award under Section 5 of the Vaccination Act of 1867 (Appendix A, No. 10).

EDUCATION IN VACCINATION.

In Appendix A, No. 11, will be found a list of Educational Vaccination Stations, with the names and addresses of the Teachers of Vaccination authorised, under Orders of the Board, to grant the Special Certificates of proficiency in vaccination necessary as part of the medical qualification for entering into contracts for the performance of public vaccination.

ANIMAL VACCINE ESTABLISHMENT

The Director of the Animal Vaccine Establishment, Mr. Thomas S. Stott, reports (Appendix A, No. 12), that during the year ending 31st March, 1904, the number of vaccinations performed at the Board's station in Lamb's Conduit Street amounted to 1,510. All of them were primary vaccinations, re-vaccination being no longer performed at this station.

GLYCERINATED CALF LYMPH.

Dr. Blaxall reports, Appendix A, No. 13, that as a consequence of cessation of small-pox in London and of limitation of the disease to comparatively few districts in the provinces, demand in 1903-04 for the Board's glycerinated calf lymph fell considerably below that of the immediately preceding years. In all, during the twelve months in question, the Board's laboratory issued 691,540 charges of glycerinated calf lymph, upwards of three-fourths of which amount was,

it appears, employed by public vaccinators in primary vaccination. As in previous years, this lymph proved on the whole of highly satisfactory quality; the results recorded in regard of the 531,997 primary vaccinations showing "Case success" of 98·4 per cent., and "Insertion success" of 93·5 per cent. MEDICAL OFFICER'S REPORT.

With better knowledge, as time has gone on, of the requirements of the Vaccination law of 1898, there has occurred better observance of that law in England and Wales. (Appendix A, No. 14.) Vaccination of infants has continued to increase, and "conscientious objection" to infantile vaccination has diminished, as is shown by the subjoined figures extracted from the Annual Returns of the Vaccination Officers made to the Board in respect of 1898 and of subsequent years. VACCINATION OFFICERS' RETURNS.

England and Wales.

Year.	Births.	Vaccinated.	Insusceptible.	Had Small-pox.	Exempted.	Died Unvaccinated.	Postponed.	Remaining.	Not accounted for (including cases postponed) per cent. of Births.
1898 ..	923,059	583,737	5,232	4	47,423	110,913	16,931	181,830	21·5
1899 ..	929,189	617,113	5,379	4	33,573	113,516	16,606	142,999	17·3
1900 ..	937,222	636,940	2,261	2	39,699	103,538	14,225	130,557	15·6
1901 ..	929,382	664,366	2,631	27	30,925	102,007	12,317	106,909	13·0
1902 ..	940,509	703,731	3,027	37	33,759	90,828	12,213	96,956	11·6

The facts which can thus be obtained as to "abstention from vaccination," from whatever cause,* are illustrated, as in previous volumes of this series, by an additional table:—

	Percentage of Births in each instance remaining unvaccinated in—					
	1893–97.	1898.	1899.	1900.	1901.	1902.
England and Wales	21·0	26·6	20·8	19·9	17·3	15·2

Passing next to counties, and dealing with years in which administration under the Act of 1898 was becoming more and more uniform throughout the country, it is found that increase

* "Abstention" comprises the "exempted" (conscientious objection) together with "postponed" and "remaining" cases.

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of infantile vaccination is now well-nigh universal, while registered objection to vaccination tends generally to diminish or to disappear, as is illustrated in the following tables:—

England.

Counties.	Certificates of Successful Vaccination.				Certificates of Conscientious Objection.			
	Percentage of Births.				Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
England	*68·0*	*70 8*	*74·8*	+ *6·8*	*4 5*	*4·5*	*3·6*	- *0 9*
Bedford	30·1	37·1	42·4	+12·3	20·2	20·3	24·1	+ 3·9
Berks	65·6	71·4	75·9	+10·3	3·9	4·4	2·3	- 1·6
Buckingham	64·9	68·7	71·0	+ 6·1	18·6	17·1	15·5	- 3·1
Cambridge	80·3	82·3	86·3	+ 6·0	4·9	4·0	2·2	- 2·7
Chester	83·3	89·9	85·8	+ 2·5	1·2	1·1	0·7	- 0·5
Cornwall	76·3	78·1	79·4	+ 3·1	3·3	3·4	2·6	- 0·6
Cumberland	74·0	75·5	77 5	+ 3·5	5·5	5·7	4·6	- 0·9
Derby	51·0	55 8	58 6	+ 7·6	3·5	5·7	4·8	+ 1·3
Devon	79·4	81·5	84·0	+ 4·6	3·2	3·0	1·3	- 1·0
Dorset	78·5	80·0	82·7	+ 4·2	4·7	4·7	3·5	- 1·2
Durham..	70·1	72·2	75·8	+ 5·7	3·1	3·1	2·4	- 0·7
Essex	62·4	66 5	69·0	+ 6·6	3 4	2·9	1·8	- 1 6
Gloucester	55·5	61·4	64·3	+ 8 8	9·4	9·8	9 6	+ 0·2
Hereford	83·1	85·9	85·6	+ 2·4	3·4	3·1	1·6	- 1 8
Hertford	74·5	73·4	79·1	+ 4·6	6·9	6·4	5·1	- 1·8
Huntingdon	82·3	86·6	88·7	+ 6·4	5·1	5·0	2·0	- 3·1
Kent (extra-metropolitan).	78·4	81·3	84·0	+ 5 6	4·6	4·8	2 6	- 2·0
Lancaster	71·9	74·8	78·1	+ 6·2	3·9	4·0	2·9	- 1·0
Leicester . ..	22·1	24·2	27·9	+ 5·8	21·9	22·6	26·2	+ 4·3
Lincoln	67 4	69·4	74·9	+ 7·5	12·8	13·0	10·5	- 2·3
London	61·7	64·3	68·0	+ 6·3	1·0	1·1	0·8	- 0 2
Middlesex (extra-metropolitan).	68·3	72·3	73·1	+ 4·8	1·8	1·7	1·2	- 0·6
Monmouth	71·1	74·4	76·3	+ 5·2	5·8	5·3	3·7	- 2·1
Norfolk	67·9	70·8	72·8	+ 4·9	15·0	12·3	10·6	- 4·4
Northampton	34·2	39·7	48·5	+14·3	15·9	17 8	28·5	+12·6
Northumberland ..	69 5	70·1	77·3	+ 7·8	3·2	3·0	2·1	- 1·1
Nottingham	57·8	64·5	69·4	+11·6	9·0	8·3	6·7	- 3·3
Oxford	74·1	75·3	78·8	+ 4·7	11·9	11·1	8·4	- 3·5
Rutland	86·5	88·4	89·2	+ 2·7	6·4	4·2	4·4	- 2·0
Salop	65·8	67·7	67 9	+ 2·3	1·9	1·7	1·0	- 0·9
Somerset	66·0	71·7	74·7	+ 6·7	8·9	9·4	7·3	- 1·6

England—continued.

Counties.	Certificates of Successful Vaccination. Percentage of Births.				Certificates of Conscientious Objection. Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
Southampton	82·9	83·7	85·1	+ 2·2	2·5	2·2	1·7	- 0·8
Stafford	65·7	71·0	78·3	+12·6	2·0	2·0	1·4	- 0·6
Suffolk	75·8	78·6	80·6	+ 4·8	6·1	5·7	3·8	- 2·3
Surrey (extra-metropolitan).	73·3	76·7	80·8	+ 7·5	3·1	3·5	2·4	- 0·7
Sussex	70·1	71·0	72·5	+ 2·4	9·4	10·1	9·1	- 0·3
Warwick	67·8	70·8	74·8	+ 7·0	2·5	3·2	2·9	+ 0·4
Westmorland	85·8	87·4	89·8	+ 3·8	3·6	3·2	1·3	- 2·3
Wilts	57·4	60·7	63·5	+ 6·1	20·3	19·6	16·7	- 3·6
Worcester	76·7	79·7	82·8	+ 6·1	2·3	2·1	1·7	- 0·6
York, East Riding ..	74·9	78·3	83·3	+ 8·4	1·5	1·3	1·1	- 0·4
York, North Riding..	71·8	71·9	75·8	+ 4·0	4·7	4·3	3·7	- 1·0
York, West Riding ..	70·4	71·0	74·9	+ 4·5	4·3	4·3	3·6	- 0·7

Wales.

Counties.	Certificates of Successful Vaccination. Percentage of Births.				Certificates of Conscientious Objection. Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
Wales	*80·5*	*82·0*	*83·6*	+ *3·1*	*0·7*	*0·6*	*0·3*	— *0·4*
Anglesey	86·3	88·3	89·9	+ 3·6	—	0·2	0·1	+ 0·1
Brecknock	85·6	82·7	83·1	- 2·5	1·5	1·7	0·7	- 0·8
Cardigan	85·1	86·0	86·7	+ 1·6	1·0	0·8	0·9	- 0·1
Carmarthen	88·0	84·7	84·8	- 3·2	0·2	0·2	0·1	- 0·1
Carnarvon	86·2	86·2	87·4	+ 1·2	0·4	0·5	0·1	- 0·3
Denbigh	85·6	87·0	88·5	+ 2·9	0·3	0·2	0·3	0·0
Flint	86·0	86·3	87·2	+ 1·2	0·1	0·0	0·1	0·0
Glamorgan	77·2	79·7	81·9	+ 4·7	0·9	0·7	0·4	- 0·5
Merioneth	77·2	86·5	86·1	+10·9	0·2	0·1	0·2	0·0
Montgomery	84·9	87·2	85·1	+ 0·2	0·6	0·4	0·1	- 0·5
Pembroke	85·7	85·5	86·2	+ 0·5	0·1	0·2	0·1	0·0
Radnor	56·3	58·6	54·1	- 2·2	2·5	3·0	0·2	- 2·3

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As regards amount of infantile Vaccination and improvement of status of counties in this particular, the years 1900 and 1902 may, using data from the above tables, usefully be contrasted as follows:—

Class.	Percentage of Births Vaccinated.	Number of Counties in Class. 1900.		Number of Counties in Class. 1902.	
1	85 – 90	11		16	
2	80 – 85	6	36	10	45
3	75 – 80	8		11	
4	70 – 75	11		8	(Bucks.)
5	65 – 70	8		3	Essex. London. Notts.
6	60 – 65	3	Bucks. Essex. London.	2	Gloucester. Wilts.
7	50 – 60	5	Derby. Gloucester. Notts. Wilts. Radnor.	2	Derby. Radnor.
8	Less than 50	3	Leicester. Bedford. Northampton.	3	Leicester. Bedford. Northampton.

It will be observed that despite the general upward tendency in the matter of infantile Vaccination above exhibited, certain counties are at the bottom of the list in both years. These counties are Leicester, Bedford, and Northampton, the shortcomings of which, along with those of others low down in the list, were last year set out Union by Union, in illustration of the diversity, inclusive of laxity, of administration by local Vaccination Authorities which contributed to this result. Details as to Unions comprised within the counties wherein in 1902 vaccination administration was found especially unsatisfactory are set out in the subjoined series of tabular statements, which follow the plan above adopted for counties as a whole. These statements relate to the 41 Unions comprised in Leicester, Bedford, Northampton, Derby, Wilts, Gloucester, and Radnor, counties which were referred to in my previous reports as among the most unsatisfactory in England and Wales. It will be seen that in five only of these 41 Unions was vaccination less abundant in 1902 than in 1900; that in not more than 15 of the 41 has conscientious objection undergone increase; and

that commonly increase of objection where it occured has not been incompatible with increase of vaccination, an increase sometimes far exceeding that credited to the ranks of the lawfully unvaccinated.

Bedford.

Union.	Certificates of Successful Vaccination.				Certificates of Conscientious Objection.			
	Percentage of Births.				Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
County	*30·1*	*37·1*	*42·4*	*+12·3*	*20·2*	*20·3*	*24·1*	*+ 3·9*
Luton	7·4	23·2	25·2	+17·8	31·0	32·3	52·7	+21·7
Bedford	17·5	20·7	26·0	+ 8·5	1·1	0·6	1·0	- 0·1
Leighton Buzzard ..	45·4	56·1	59·5	+14·1	37·4	33·3	31·2	- 6·2
Ampthill	58·0	62·6	69·1	+11·1	21·7	19·7	15·1	- 6·6
Biggleswade	66·7	62·9	74·2	+ 7·5	22·6	24·8	14·9	- 7·7

Northampton.

Union.	Certificates of Successful Vaccination.				Certificates of Conscientious Objection.			
	Percentage of Births.				Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
County	*34·2*	*39·7*	*48·5*	*+14·3*	*15·9*	*17·8*	*28·5*	*+12·3*
Wellingborough ..	10·0	25·4	43·2	+33·2	10·9	9·4	33·6	+22·7
Northampton	13·2	22·0	30·4	+17·2	22·1	28·8	44·5	+22·4
Kettering	17·3	12·3	24·1	+ 6·8	13·4	15·0	37·1	+23·7
Thrapston	40·8	45·6	49·7	+ 8·9	46·5	45·8	38·9	- 7·6
Towcester	48·1	52·5	59·5	+11·4	30·5	21·2	23·6	- 6·9
Hardingstone	48·5	47·8	60·5	+12·0	33·6	37·4	29·1	- 4·5
Brixworth	54·3	67·9	71·2	+16·9	5·6	13·8	13·1	+ 7·5
Daventry	57·3	65·9	70·9	+13·6	12·3	16·4	15·4	+ 3·1
Brackley	59·8	55·0	67·1	+ 7·3	10·8	13·6	9·6	- 1·2
Potterspury	57·1	60·3	66·9	+ 9·8	27·3	28·6	21·8	- 5·5

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Derby.

Union.	Certificates of Successful Vaccination.				Certificates of Conscientious Objection.			
	Percentage of Births.				Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
County	*51·0*	*55·8*	*58·6*	*+ 7·6*	*3·5*	*5·7*	*4·8*	*+ 1·3*
Derby	13·8	25·7	26·1	+12·3	2·0	8·1	6·8	+ 4·8
Shardlow	48·1	57·1	73·0	+24·9	4·0	5·2	4·2	+ 0·2
Glossop	57·5	57·3	67·9	+10·4	20·0	23·5	17·0	- 3·0

Wilts.

Union.	Certificates of Successful Vaccination.				Certificates of Conscientious Objection.			
	Percentage of Births.				Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
County	*57·4*	*60·7*	*63·5*	*+ 6·1*	*20·3*	*19·6*	*16·7*	*- 3·6*
Trowbridge and Melksham.	27·3	24·0	26·8	- 0·5	12·8	8·7	4·4	- 8·4
Swindon and Highworth.	45·5	51·0	54·3	+ 8·8	37·6	34·4	31·4	- 6·2
Chippenham	45·8	57·3	57·9	+12·1	12·9	13·1	11·5	- 1·4
Bradford-on-Avon ..	47·0	41·5	44·9	- 2·1	7·7	11·5	10·2	+ 2·5
Devizes	54·5	59·1	62·6	+ 8·1	30·6	28·7	24·7	- 5·9
Calne	54·9	51·8	53·8	- 1·1	11·8	9·0	6·9	- 4·9
Cricklade and Wootton Bassett.	57·0	55·9	55·9	- 1·1	25·9	31·4	30·5	+ 4·6

Gloucester.

Union.	Certificates of Successful Vaccination. Percentage of Births.				Certificates of Conscientious Objection. Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
County	*55·5*	*61·4*	*64·3*	+ *8·8*	*9·4*	*9·8*	*9·6*	+ *0·2*
Tewkesbury	23·9	41·6	55·3	+31·4	23·3	23·2	17·9	- 5·4
Gloucester	33·3	45·0	43·7	+10·4	20·8	22·9	33·1	+12·3
Stroud	38·8	49·5	51·7	+12·9	19·3	14·3	18·1	- 1·2
Westbury-on-Severn	42·4	46·7	49·7	+ 7·3	39·2	44·5	41·1	+ 1·9
Wheatenhurst ..	51·1	54·9	60·0	+ 8·9	14·8	16·8	16·4	+ 1·6
Cheltenham	52·0	52·4	62·2	+10·2	19·5	23·1	18·2	- 1·3
Bristol	57·4	63·7	65·8	+ 8·4	2·4	2·4	2·1	- 0·3
Dursley	63·9	61·8	67·9	+ 4·0	20·4	20·8	16·9	- 3·5

Leicester.

Union.	Certificates of Successful Vaccination. Percentage of Births.				Certificates of Conscientious Objection. Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
County	*22·1*	*24·2*	*27·9*	+ *5·8*	*21·9*	*22·6*	*26·2*	+ *4·3*
Leicester	5·1	7·4	9·9	+ 4·8	9·6	8·1	17·9	+ 8·3
Barrow-on-Soar ..	18·9	23·5	38·4	+19·5	43·5	47·1	41·5	- 2·0
Loughborough ..	22·0	24·4	31·7	+12·7	43·9	46·7	42·0	- 1·9
Hinckley	34·4	39·0	41·0	+ 6·6	33·0	41·5	43·8	+10·8
Market Bosworth ..	37·0	44·2	47·9	+10·9	41·4	37·9	40·5	- 0·9
Market Harborough	50·0	48·4	55·3	+ 5·3	37·6	39·1	35·4	- 2·2

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Radnor.

Union.	Certificates of Successful Vaccination. Percentage of Births.				Certificates of Conscientious Objection. Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
County	*56·3*	*53·6*	*54·1*	*- 2·2*	*2·5*	*3·0*	*0·2*	*- 2·3*
Rhayader	39·1	32·5	31·0	- 8·1	0·4	0·9	0·4	0·0
Knighton	69·8	71·4	75·0	+ 5·2	4·1	4·8	—	- 4·1

With reference to the Metropolis, which, as shown in previous reports, comprises Unions as unsatisfactory almost in the matter of vaccination administration as any in England and Wales, the data for 1902 are, owing perhaps to small-pox prevalence in London in that year, somewhat better than those for previous years, as will be seen from the appended tabular statement:—

—	Certificates of Successful Vaccination. Percentage of Births.				Certificates of Conscientious Objection. Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
London	*61·7*	*64·3*	*68·0*	*+ 6·3*	*1·0*	*1·1*	*0·8*	*- 0·2*
Bethnal Green ..	38·2	35·8	45·1	+ 6·9	0·4	0·4	0·3	- 0·1
Camberwell	65·2	70·6	69·6	+ 4·4	1·0	0·8	0·6	- 0·4
Chelsea	74·1	76·0	75·2	+ 1·1	1·3	0·8	1·3	0·0
Fulham	75·7	78·3	78·2	+ 2·5	1·4	1·2	1·0	- 0·4
George, St, Hanover Square.	82·2	84·8	83·9	+ 1·7	1·2	0·5	0·6	- 0·6
George, St., in the East.	58·6	59·0	61·8	+ 3·2	—	0·0	0 1	+ 0·1
Giles, St., and St. George.	59·0	60·1	62·5	+ 3·5	0·2	0·3	0 1	- 0·1
Greenwich	75·0	77·5	78·3	+ 3·3	1·2	1·3	0·8	- 0·4
Hackney	46·8	49·0	62·8	+16·0	1·0	1·0	0·8	- 0·2
Hammersmith ..	80·5	81·3	80·9	+ 0·4	1·2	1·4	1·8	+ 0·6

	Certificates of Successful Vaccination.				Certificates of Conscientious Objection.			
	Percentage of Births.				Percentage of Births.			
	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.	1900.	1901.	1902.	Increase or decrease of 1902 on 1900.
Hampstead	81·5	81·7	82·7	+ 1·2	2·3	2·6	1·8	- 0·5
Holborn	60·7	60·8	65·4	+ 4·7	0·6	0·8	0·4	- 0·2
Islington	64·2	68·9	72·8	+8·6	1·3	1·1	0·8	- 0·5
Kensington	80·3	81·0	83·1	+ 2·8	1·1	1·3	0·7	- 0·4
Lambeth	68·1	67·6	70·5	+ 2·4	1·2	1·3	1·0	- 0·2
Lewisham	68·7	74·5	78·1	+ 9·4	2·2	2·1	1·7	- 0·5
London, City of ..	72·2	74·3	79·0	+ 6·8	2·0	2·6	0·9	- 1·1
Marylebone, St. ..	72·4	76·3	78·7	+ 6·3	0·4	0·6	0·4	0·0
Mile End Old Town..	20·8	24·9	31·1	+10·3	0·3	0·3	0·2	- 0·1
Olave, St.	64·8	69·6	71·8	+ 7·0	0·5	0·9	0·4	- 0·1
Paddington	75·6	79·5	80·6	+ 5·0	1·1	1·0	0·6	- 0·5
Pancras, St.	56·1	56·6	63·4	+ 7·3	1·0	0·9	0·7	- 0·3
Poplar	36·1	39·1	44·4	+ 8·3	0·5	0·4	0·3	- 0·2
Shoreditch	32·0	41·3	51·5	+19·5	0·2	0·3	0·3	+ 0·1
outhwark	58·2	60·1	62·2	+ 4·0	1·0	0·6	0·5	- 0·5
Stepney	41·1	43·7	51·4	+10·3	0·2	0·4	0·3	+ 0·1
Strand	70·9	74·2	73·5	+ 2·6	0·8	0·9	0·4	- 0·4
Wandsworth and Clapham.	65·6	69·1	71·6	+ 6·0	1·7	1·7	1·4	- 0·3
Westminster	79·4	79·0	79·9	+ 0·5	1·2	0·7	0·9	- 0·3
Whitechapel	78·0	80·7	83·5	+ 5·5	0·3	0·5	0·2	- 0·1
Woolwich	82·3	80·9	82·0	- 0·3	2·4	3·6	2·2	- 0·2

But progress in improvement of vaccination administration in the Metropolis is slow. Notwithstanding severe prevalence of small-pox in London in the year now in question, and panic arising therefrom, no single Metropolitan Union attained for 1902 the satisfactory standard (above 85 per cent.) in "Births Vaccinated," which was in the same year secured in no less than 16 of the 55 counties of England and Wales. Vaccination administration in London, indeed, though on the whole improved, remains as diverse and as unequal in its results as before, which is the more to the discredit of not a few Metropolitan Boards of Guardians and their officers, seeing that in London the "conscientious objector" is but rarely found. The subjoined table gives the status, actual and relative, of the

several Metropolitan Unions as regards acceptance of infantile vaccination in the years 1900 and 1902:—

Metropolitan Unions.

Percentage of Births Vaccinated.	Unions in each Class.	
	1900.	1902.
85 – 90	Nil.	Nil.
80 – 85	5 St. George, Hanover Sq. Hammersmith. Hampstead. Kensington. Woolwich.	7 St. George, Hanover Sq. Hammersmith. Hampstead. Kensington. Paddington. Whitechapel. Woolwich.
75 – 80	5 Fulham. Greenwich. Paddington. Westminster. Whitechapel.	7 Chelsea. Fulham. Greenwich. Lewisham. City. Marylebone. Westminster.
70 – 75	4 Chelsea. City. Marylebone. Strand.	5 Islington. Lambeth. Strand. Wandsworth. St. Olave.
65 – 70	4 Camberwell. Lambeth. Lewisham. Wandsworth.	2 Camberwell. Holborn.
60 – 65	3 Holborn. Islington. St. Olave.	5 St. George in the East. St. Giles. Hackney. St. Pancras. Southwark.
50 – 60	4 St. George in the East. St. Giles. St. Pancras. Southwark.	2 Shoreditch. Stepney.
Less than 50	6 Bethnal Green. Hackney. Mile End. Poplar. Shoreditch. Stepney.	3 Bethnal Green. Mile End. Poplar.

Small-pox Administration Abroad.

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GERMAN METHOD OF DEALING WITH SMALL-POX.

Disappearance from Germany of epidemic small-pox is a fact altogether without question. For more than a generation, ever since Germany adopted compulsory vaccination and re-vaccination, sanitary administration in that country has been practically untroubled by this disease. This freedom of Germany from small-pox has, it is asserted by objectors to vaccination, been due less to universality of acceptance of primary succeeded by secondary vaccination than to prompt systematic and vigorous isolation of each small-pox case as it arose. In the circumstances Mr. Long determined, partly in the interests of science, but mainly in reference to administrative and financial considerations, to ascertain through your Medical Department what in the present is the German method of dealing with small-pox outbreaks. Accordingly Dr. Bruce Low, one of the Board's Assistant Medical Officers, having been furnished by the Foreign Office with necessary credentials to the German Government, has visited Germany and made inquiry in certain representative towns of the chief States of that country as to current methods of suppressing small-pox.

As a result of his investigations (Appendix A, No. 15), Dr. Low ascertained that the machinery, preventive and other, for dealing with small-pox in Germany comprises:—

(*a.*) Compulsory vaccination of all infants before the end of the calendar year next succeeding that of their birth; and compulsory re-vaccination of all children in their twelfth year: compliance of parents with the above requirements as to vaccination and re-vaccination being enforced by fine or imprisonment.

(*b.*) Notification of all cases of small-pox.

(*c.*) Powers to isolate in hospital cases of small-pox or of suspected small-pox.

(*d.*) Vaccination or re-vaccination of the "contacts" in small-pox invaded houses, and, in some towns, isolation of such contacts.

With reference to measures of isolation, Dr. Low found that, save in rare instances, there exist in Germany no specially provided small-pox hospitals. That, owing to the system of vaccination and re-vaccination there in force, the demand made by small-pox upon isolation accommodation is so trivial that in the majority of places one of the pavilions of the "General Diseases Hospital" within the town has sufficed in all ways for dealing with small-pox emergencies. Now and again, it is true, Dr. Low found a single pavilion nominally allotted for small-pox; but almost invariably such pavilion was, in the absence of small-pox, used for the other and general purposes

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of the hospital establishment. Further, it appeared that such small pox pavilion, even when in use for small-pox, was in most instances allowed to remain, administratively as well as structurally one, with the hospital establishment of which, in ordinary circumstances, it constituted a part. Similarly, it is not deemed needful in Germany, when small-pox is being accommodated in this section of a local hospital, to require re-vaccination of the hospital staff or of the "general" patients in the establishment, reliance against spread of the small-pox being placed on the routine statutory primary vaccination and re-vaccination that these persons have already undergone. Persons, however, who are of necessity brought into near and sustained relations with the small-pox patient, or patients, in the hospital have to submit to a further vaccination.

An excellent illustration of the trifling expense and trouble to which Germany is put in the matter of isolation of small-pox is afforded by Berlin, with a population of near upon two million persons. For this city the sole provision for small-pox is a pavilion containing twelve beds at the Royal Charité Hospital, which can accommodate at one and the same time some 1,500 patients suffering from a variety of maladies, medical, surgical, and other. The relation of this small-pox pavilion to the rest of the Royal Charité Hospital and to Berlin is shown on the map of the city reproduced along with Dr. Bruce Low's report in this volume.

So far as Dr. Low was able to ascertain, and he was careful to make special and detailed inquiries on the subject, no serious inconvenience has at any time attended the method of small-pox isolation now adopted by Germany. Furthermore, it appears that all the officers and physicians with whom Dr. Low conferred on the matter were unanimous in attributing the immunity from small-pox enjoyed by the population in the neighbourhood of small-pox pavilions in Germany to the systematic enforcement of statutory vaccination and re-vaccination. But for this antecedent precaution, all these persons agreed, it would be necessary to establish, outside the town limits in each instance, a small-pox hospital, distinct and separate from the local hospital provided for "general" disease.

To those of us who are familiar with the difficulties experienced in this country, in the past and in the present, in procuring sites for small-pox hospitals, the advantages over our own of the German method of repressing small-pox must needs appear indisputable. It is not possible to deny that had this country given heed, as Germany has done, to the lessons of the small-pox pandemic of 1870-73, London might have been saved the enormous cost which she has since been called upon to bear in removal and maintenance of her small-pox hospitals beyond the Metropolis.

Similarly, provincial towns might have escaped much direct expense and serious dislocation of trade through small-pox;

while sanitary authorities generally would almost certainly have been spared much anxiety and the no little expense arising to them from the habit of our towns of distributing on occasion small-pox throughout the country. Not until re-vaccination has become practically universal with us at ages (say) 12-15 years may we hope to avoid the recurrent disadvantages arising in this country through the liability of a large proportion of our adolescent and adult population to contract and to transmit small-pox.

Certain figures respecting public vaccination and public re-vaccination in the German Empire are of interest in connexion with the measures upon which I have reported as adopted in that country in repression of small-pox. The data in question, which relate to the six years 1896-1901, have been extracted by Dr. Bruce Low from the Official Medizinal Statistische Mittheilungen aus dem Kaiserlichen Gesundheitsamte:—

YEAR.	INFANTS.			CHILDREN.		
	Number due to be vaccinated.	Percentage actually submitted to vaccination.	Percentage successfully vaccinated.	Number due to be re-vaccinated.	Percentage actually re-vaccinated.	Percentage successfully re-vaccinated.
1896	1,670,598	83·47	81·40	1,176,070	96·83	89·81
1897	1,737,878	83·74	81·09	1,211,672	96·96	88·81
1898	1,763,442	83·97	81·58	1,234,276	96·83	88·80
1899	1,791,191	84·06	80·78	1,271,207	96·78	88·41
1900	1,814,310	83·70	81·20	1,287,155	96·82	90·34
1901	1,809,137	84·00	81·29	1,268,281	96·82	90·67

PLAGUE.

Plague continued during 1903 to prevail in India with unabated virulence. From Dr. Bruce Low's Summary of the progress and diffusion of this disease throughout the world (Appendix A, No. 16), it appears that plague deaths in India, which in the previous year had amounted to above half a million, further increased in 1903 to no less than 800,000. Most of the presidencies, provinces, or states which had previously suffered much from the disease, shared in this increase of mortality, the Punjab and the Mysore State being in this sense the only exceptions; and further, certain divisions of the country which hitherto had not exhibited much plague—the Central Provinces, Hyderabad State, and Central India, for

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instance—began in 1903 to suffer heavily. Of other Far East countries, China alone appears to have suffered in 1903 severely from plague; in Canton and neighbouring districts the disease is reported to have proved more virulent in 1903 than in any one of the three preceding years. Japan, however, hardly suffered at all from plague; and though outbreaks occurred in the Philippines, the Straits Settlements, Siam, French Indo-China and New Caledonia, in none of these localities did the disease assume alarming proportions. So, too, with certain of the Australian Colonies, with the Hawaiian Islands, Mexico, Peru, Chili, and Brazil, though plague made its appearance in particular quarters the disease betrayed in none of them tendency to epidemicity.

Nearer home, in Cape Colony, sporadic plague only was notified from time to time throughout the year. But at Durban there occurred a limited outbreak, and in the Mauritius plague was somewhat more prevalent than in previous years. Egypt, in the first six months of 1903, manifested plague in nearly a dozen different localities; in none, however, did the disease become seriously prevalent; always it soon died down.

Marseilles suffered in the autumn of the year a small outbreak of plague among workers at a cardboard factory, but the disease here was quickly suppressed. In Berlin there occurred a fatal case of plague in the person of a medical man engaged in laboratory investigation of B. pestis, the disease extending in this instance to one other person, a male nurse who attended on the medical man in question. No case of plague occurred during 1903 in the United Kingdom, and in no single instance was actual plague brought by shipping to our shores.

Cholera.

In no part of the world did cholera exhibit in 1903 notable activity. In India this disease was indeed somewhat more prevalent than in the previous year, especially in Bengal; and it prevailed also to a considerable though uncertain extent over a wide area of China. But in Japan and in the Philippines there was less cholera than in 1902. The Mohammedan Holy Land, Egypt, and Palestine, which had suffered severely from the disease in 1902, to an extent indeed and in circumstances raising apprehension of spread of the malady to Europe, manifested in 1903 hardly any cholera. Syria, however, invaded through Egypt and Palestine late in 1902, suffered in 1903 considerably, and for a while cholera in that country constituted a menace to Europe. But the disease in extending from Syria trended not West, as had been anticipated, but East into the Euphrates Valley, and then travelled southward by this route

in the direction of the Persian Gulf. This unexpected behaviour of cholera, after arrival on the borders of Europe by way of Egypt, is dealt with in considerable detail by Dr. Bruce Low in his Report on "The Manifestations of Cholera throughout the World during 1903" (Appendix A, No. 17). MEDICAL OFFICER'S REPORT.

As in 1902 so in 1903 no vessel arriving from abroad brought actual cholera to our shores.

Auxiliary Scientific Investigations.

As pointed out by your Medical Officer in his "Introduction" to Reports and Papers by Dr. Bruce Low on Bubonic Plague,* the relations of rats and plague had by July, 1902, become a question of important administrative concern. In that year therefore the Board instructed Dr. Klein to make study of rat-plague in a variety of aspects. As noted in my report for 1902-03, Dr. Klein, as a result of work thus undertaken for the Board, satisfied himself as to the existence in the rat of two forms of plague; a virulent and presumably highly infectious strain, and a strain of insignificant virulence with correspondingly feeble infectiveness. The latter form of plague Dr. Klein provisionally regarded as that "proper" to the rat, at any rate in temperate zones, and it was by assumption of predominance in this animal of plague of this quality that he was disposed to account for certain striking facts of which your Medical Department had been taking note, namely, an observed tardy extension of rat plague in most countries, and especially a small ability of plague-affected rats to foster plague on shipboard or to set the disease going among our seaport populations. RATS AND PLAGUE.

It was while Dr. Klein was obtaining indications of the above sort, that the question of the concern of the rat with plague became, administratively, more urgent than before. Many writers on the subject, especially scientists abroad, were not only definitely accepting the rat as the chief source of plague in man but were representing ship-borne rats as practically the sole agency of transmission of this disease from port to port of maritime countries. Thus it happened that about June, 1903, demand arose for international consideration of the rôle of the rat in propagation of plague, with a view to formulation of stringent measures in repression of rats and of rat-plague, such measures to be obligatory under Convention, to which it was anticipated all the Western Powers would agree to give adherence. Great Britain, almost alone among the

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* "Reports and Papers on Bubonic Plague by Dr. Bruce Low; with an Introduction by the Medical Officer of the Local Government Board." [Cd. 748.], 1902.

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nations, demurred, as has been said, to these proposals, considering, in view of the data respecting the association of rats with plague collected by the Local Government Board and of the etiology of rat-plague as indicated by Dr. Klein's researches, that the time was not yet ripe for dealing with the subject on an international basis; that there was prospect indeed of international opinion making too grave an estimate of the danger of plague accruing through ship-borne rats, and risk consequently of unnecessary restrictions being forced on the shipping trade, to the detriment of commerce throughout the world. Nevertheless Great Britain did not, in view of the consensus of desire on the part of other European countries, press objection to the proposed International Conference, which in the end assembled at Paris in October, 1903, with the results to which I have already referred, pages ix. to xi.

In these circumstances it was judged expedient that details of Dr. Klein's researches into the etiology and pathology of rat-plague should be forthwith printed, and that Dr. Theodore Thomson should summarise the information accumulated in the Medical Department on the subject of the rôle of the ship-borne rat in dissemination of plague; so that both these documents might be available for the Delegates of the several nations. This was accordingly done; and I make no doubt at all that such success as was attained at the Paris Conference in counteracting proposals for extra stringent plague measures in regard of shipping was largely due to the facts set forth in these reports of Drs. Klein and Thomson, and not least to Dr. Thomson's exposition of the facts in question in their bearing on administrative plague measures, general and particular. Dr. Klein's report, which was thus submitted to Delegates at the Paris Conference, entitled "Pathology and Etiology of Rat-plague and other Infectious Rat-Diseases," has already appeared in your Medical Officer's Report for 1902-03 (page 399); Dr. Thomson's "Memorandum on Rats and Ship-borne Plague" is reproduced as Appendix B, No. 1, to this Volume.

In relation with the question of transmission of plague from rat to man, further investigations, in continuance of those formerly made on behalf of the Board by Dr. Haldane, were conducted in 1903 and 1904 with a view to ascertaining the means by which the destruction of rats on board ship may best be secured. They take account, however, not merely of the effect upon rats of the methods of "destruction" investigated, but also of their effect upon insects and their value as means of disinfection. Reports on these subjects by Drs. Haldane and Wade, who conducted the investigations, will be found in Appendix B, No. 2.

The first of these reports records Dr. Haldane's observations of the results attained by the "Clayton" process, as applied in the case of the steamship *Bavaria* at the port of Dunkirk.

In this instance Dr. Haldane found that this process, while bringing about destruction of rats and other vermin in cabins, empty holds, and the like, had largely failed to secure this end in holds full of cargo. The cargo of the *Bavaria* consisted mainly of seeds, grain, and jute, and Dr. Haldane concluded that it had been imperfectly penetrated by the "Clayton gas."

The second report, by Dr. Wade, gives an account of experiments made with a view to ascertaining the influence of the "Clayton" process and of sulphur dioxide on rat and insect life and their value as disinfecting agencies. In detail, Dr. Wade's researches bear upon the composition of "Clayton gas," the toxic effect of sulphur dioxide upon rats and insects, its bactericidal properties, the time required for complete penetration of cargo by sulphur dioxide, and the question of how far damage to certain articles may result from their submission to treatment by sulphur dioxide processes. Dr. Wade finds that "Clayton gas" consists, in addition to nitrogen and oxygen, of sulphur dioxide and a small proportion of sulphur trioxide; the last-mentioned constituent, however, not affecting the toxic influence or penetrative power of the gas. The "Clayton" process is, in fact, substantially a sulphur dioxide process.

It appears from Dr. Wade's experiments that many articles, notably wool, jute, flour, seeds, and grain, absorb large quantities of sulphur dioxide, with the result that this gas penetrates these substances in bale or as masses of cargo very slowly. Hence it would appear that sulphur dioxide processes, notwithstanding the rapidly fatal effect of this gas on the life of rats, insects, and certain pathogenic organisms, may fail to exert destructive action, within any reasonable time, on these animals, insects and organisms when secreted within the interstices of cargo. Dr. Wade also finds that exposure to sulphur dioxide renders most foodstuffs, such as fruit, vegetables, and meat, uneatable, and damages, in less degree, various other articles.

In the third report Drs. Haldane and Wade discuss, in the light of the increased knowledge accruing from their investigations, the merits and demerits of the several processes proposed for destruction of rats on ship-board; dealing, in this aspect, with the "Clayton" process, the burning of sulphur on shipboard, the use of liquid sulphurous acid, and the employment of carbon monoxide and carbon dioxide.

Substantially, they arrive at the conclusion that no one of these methods is free from objection, and that the greater or less suitability of each varies with the often-varying circumstances involved, more particularly according as the treatment is to be applied to vessels with cargo *in situ* or after discharge of cargo. They consider that, on the whole, a sulphur dioxide process would be the most generally useful; and suggest that,

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where holds full of cargo have to be dealt with, the difficulty created by failure of the gas to penetrate might be partly overcome by the addition of a small proportion of carbon monoxide to it.

The practical difficulties of the administrative problem with which the investigations of Drs. Haldane and Wade have concern are considerable, and the additional knowledge that has resulted from their researches, although of high value, nevertheless leaves room for further inquiry. Further investigation, therefore, of this subject is being pursued.

ACILLUS ESTIS.

Dr. Klein, in his further observation in 1903-04 of Bacillus pestis (Appendix B, No. 3), has continued study, in their morphological, cultural, and physiological aspects, of the two types of plague bacillus already described by him. The additional experience thus gained goes to confirm the biological distinction between these two types to which Dr. Klein drew attention last year, and similarly his studies serve to illustrate the stability in each instance of these two different strains of bacillus as regards morphological and cultural features. And further the all-important primary distinction between B. pestis of the "human" type (type I.) and B. pestis of the "rat" type (type II.) is found, as before, to be difference as regards initial virulence to rodents; the former is highly pathogenic to these animals, the latter much less so. But also these two types are found now to differ secondarily in a way which is not a little interesting. In the laboratory, B. pestis of type I. (human) commonly maintains its initial virulence through many removes in sub-culture, and when under these artificial conditions the pathogenicity of this strain of plague does in the end diminish, full virulence can at once be restored to the bacillus by passing it again through the animal body. On the other hand, B. pestis of the "rat" type (type II.) not only quickly parts under repeated sub-cultures with such virulence as it originally possessed, but fails on being again passed through the animal body to regain its pristine pathogenicity.

Recognising that these two types of plague bacillus have in all probability descended from a common stock, Dr. Klein sought means of converting type I. into type II., and, by reverse process, type II. into type I. In the latter sense he has not yet made definite progress. But in the first of these objects Dr. Klein has met with a considerable share of success. By inoculating plague material of high degree of virulence into rats antecedently protected by administration subcutaneously of Haffkine's prophylactic, he obtained from the local gland affection sometimes induced in this way a B. pestis, which, though culturally (except in minor features) of type I., was in a morphological sense found to be degenerating, and which on direct transference to rodents proved considerably less virulent than the strain of B. pestis whence it was derived. The

plague bacillus thus rendered, as it were, unstable, underwent on passage through successive rats, further modification culturally in the direction of type II., meanwhile retaining its new characteristic of enfeebled virulence.

Dr. Klein concludes his paper on this subject with a detailed account of the anatomical appearances observed in rats and mice as the result of employing his different types of plague bacillus to infect these animals by cutaneous inoculation.

AIR CONTAMINATION.

Dr. Mervyn Gordon has continued his investigations respecting contamination of the air of dwelling rooms and public buildings by particulate matter emanating directly from the bodies of persons assembled within them.

In a previous report Dr. Gordon has shown that a certain micro-organism, "*Streptococcus brevis*," by reason of the fact that it is invariably present in great number in the saliva of all persons, may serve as a useful index of the presence of particles of saliva in the air. Droplets of saliva are, it appears, apt to be expelled with the breath in the acts of coughing, sneezing and loud speaking, and by means of his streptococcus test Dr. Gordon has been enabled to detect the dispersion of particles of saliva in the air of a room to a distance of 40 feet from a person who delivered an oration for the space of one hour.

In the course of the experiments by which presumption was thus obtained as to the high value of his streptococcus test for demonstrating the presence of particles of saliva, Dr. Gordon found that a certain streptococcus of other than salivary origin was not infrequently met with in air. Accordingly it became of especial importance that all available means should be sought for differentiating his streptococcus of saliva from all other and "foreign" streptococci.

Previous experience having shown that it was in reference to divergence of bio-chemical characters the best hope lay of differentiating streptococci, Dr. Gordon has (Appendix B, No. 4) made inquiry in which a series of 10 streptococci, representative of the streptococcus group, were cultivated in a medium charged in succession with a series of organic substances of known composition each easily decomposable; decomposition of the substance in each instance being accompanied by development of acid reaction, which was made readily recognisable by previously tinting the medium with litmus. In this way a number of tests were found available for differentiating streptococci, nine of which tests were subsequently selected for application to a large number of these micro-organisms isolated from a great variety of sources.

As a result of these investigations Dr. Gordon has been able to show that differentiation of members of the streptococcus group is practicable to a degree previously unknown and, indeed, unsuspected; and that in particular the streptococci

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specially characteristic of saliva differ in marked, definite, and constant manner from other streptococci. Incidentally, too, in the application of his differential tests to streptococci isolated from the human body in disease, Dr. Gordon made some observations which cannot fail to prove of interest to the clinical pathologist. For instance, his differentiation of streptococci associated with suppuration and septicæmia from streptococci found in connection with ulcerative endocarditis, and his identification of the latter micro-organisms with types of streptococci most abundant in normal human saliva.

In addition to the question of breath-contamination of the atmosphere, it appeared desirable to ascertain the extent to which the air of inhabited rooms may become contaminated by particles of skin and scurf. Dr. Gordon was accordingly instructed to ascertain whether any micro-organisms might, by the constancy of their presence on particles of skin and scurf, serve to identify such particles present in the air. In this connexion a preliminary investigation showed that the micro-organisms most abundantly and constantly found associated with skin and scurf were always staphylococci. But the characters at present commonly recognised as differentiating staphylococci having been found unsatisfactory for the object in view, it has been found necessary to investigate the biochemical qualities of the staphylococcus group in the fashion already adopted with streptococcus.

Six representative staphylococci were therefore selected and investigated with reference to their decomposing action on various carbo-hydrates, glucosides, &c., and with the result that a number of tests were found to be available for the purpose of differentiating members of this group. Eight of these differential tests were next selected, and a number of staphylococci of various origin submitted to them. The data so far obtained may be said to offer promise of the eventual acquisition of a staphylococcus test of the nature desired.

IXED NFECTIONS."

In connexion with questions of human immunity from infectious diseases instances frequently call for consideration in which, out of a considerable number of persons exposed to a common bacterial infection under similar conditions, some are attacked with greater or less severity, while others escape altogether. In the instances in question there is often no reason to suppose that the factor which determined these individual differences has been the quantity of the infecting dose, and these differences remain after due allowance has been made for certain obvious distinctions—in the matter of previous attack, age incidence, and the like—which it is possible to draw between the susceptible and the immune. Among a variety of considerations which arise in such cases is the question of "mixed infection." It is well known that the clinical course and severity of certain infectious diseases—for example, scarlatina, diphtheria, tuberculosis—are in large measure dependent on the association of pyogenic or other bacteria with the

specific organism of the disease. It does not seem improbable that the presence of other bacteria, or of their recently formed products, may in certain instances have an important influence at an earlier stage, *i.e.*, in enhancing or limiting the opportunities afforded to the specific organism, at the time of its introduction into the tissues, to multiply and exercise toxic effect there. Certain etiological observations (*e.g.*, the frequent association of non-diphtheritic sore throat and diphtheria, or of preliminary diarrhœa with the later appearance of enteric fever) tend to support this suggestion. Investigation of the subject by animal experiment presents numerous difficulties, even when the conditions of experiment are comparatively simple. Many years ago some early inquiries by Dr. Klein as to the effect on rabbits of simultaneous inoculation of certain different species of bacteria and bacterial products were recorded in these reports,* and in the present volume (Appendix B, No. 5) Dr. Klein gives the results of some new investigations in the same direction.

For this purpose he took an originally pathogenic microbe—B. typhosus—which as a result of many generations of sub-culture in the laboratory no longer produced pathogenic effect when inoculated, intraperitoneally, into guinea-pigs, and he conducted a series of experiments to ascertain how far the pathogenic effect of such inoculations was regained if the animal at the same time or soon afterwards received doses of certain other pathogenic microbes which also of themselves were incapable of producing more than a transient local effect. The additional micro-organisms used for these experiments were respectively two varieties of B. coli, an attenuated form of B. Gaertner, B. enteritidis, and another pathogenic anaërobe, "B. carnis." In some instances the inoculation of the additional microbe, like that of the B typhosus, was intraperitoneal; in others B typhosus was inoculated intraperitoneally, and the additional microbe subcutaneously.

A similar series of experiments, using the same additional bacteria, was made with a specimen of cholera vibrio, which also on account of long sub-culture in the laboratory had lost its pathogenicity to guinea-pigs on intraperitoneal inoculation. In the third series advantage was taken of the circumstance that in certain conditions diphtheria bacilli from dry agar cultures produce little or no effect when inoculated intraperitoneally into guinea-pigs, to ascertain whether simultaneous inoculation of Streptococcus pyogenes in amounts which themselves are without toxic effect on the guinea-pig would permit multiplication or toxic action of either or both of these micro-organisms.

In some of the above experiments computation of the dose which by itself could be safely assumed to be without material effect on the experimental animal was not easy, and, as

* Annual Report of Board's Medical Officer for 1889, p. 215.

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Dr. Klein shows, it is impossible to draw inferences from certain of the results obtained. As a whole, however, the observations show that the presence of certain of the additional bacteria—notably, in the case of B. typhosus, one variety of B. coli and "B. carnis," and in the case of B. diphtheriæ, Streptococcus pyogenes—did enhance, in an unmistakable manner, the pathogenic action of the attenuated bacillus of experiment; while in other instances (*e.g.*, in the case of Cholera vibrio, B. coli and B. Gaertner) no such effect was produced. In one experiment (B. typhosus and B. coli) Dr. Klein inoculated along with the B. typhosus, not the living B. coli, but merely its toxin. In this instance also active multiplication and pathogenicity of the attenuated B. typhosus followed; a result which it should be useful to remember in connexion with questions of individual susceptibility to enteric fever.

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The toxic substance proper to the protoplasm of Proteus, and which is also excreted, as it were, by this micro-organism when under culture in peptone broth, has been made by Dr. Sidney Martin the subject of further study (Appendix B, No. 6). His object has been to ascertain the effect of repeated inoculation of rodents with sub-lethal doses of proteus toxin in conferring on their blood serum the power of agglutinating proteus bacilli; and, having achieved this, of testing the ability of such serum, when intravenously injected antecedent to or simultaneously with a lethal amount of proteus toxin, to secure other rodents against proteus infection.

Rabbits were the rodents experimented with; but unhappily they proved unsatisfactory for Dr. Martin's purposes, owing seemingly to a diversity, altogether irrespective of body weight, of susceptibility among rabbits to like amounts of the same sterilized proteus culture. As regards, however, certain of these animals which successfully responded to repeated subcutaneous injection of the toxin, Dr. Martin found that proteus agglutinin quickly appeared in their blood, often in considerable amount. But he did not find that in the blood of these same animals proteus anti-toxin was developed in a degree in any sense parallel with the appearance there of proteus agglutinin. Some of Dr. Martin's prepared rabbits did, it is true, yield serum possessing some slight anti-toxic power; but commonly their serum was wholly without anti-toxic effect, in particular instances indeed administration of it to other rabbits appeared to have enhanced the toxic effect of proteus toxin injected along with it.

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Dr. Houston reports (Appendix B, No. 7), his further investigation of the biology of excrement and of water. In Division I. of this report the results are given of Dr. Houston's additional study of healthy human fæces; Division II. supplies record of extension of his biological examinations to the intestinal contents of fish and seafowl; and in Division III., which deals with bacteriological contrast of raw and filtered river waters, Dr.

Houston considers the rationale of artificial purification of public water supplies in the light of the multitudinous testings of earth, of excrement, of sewage, and of water upon which he has been for many years engaged.

The chief interest, and indeed merit, of Dr. Houston's work in the above connexion is its concern with the status of Bacillus coli as an indicator of previous undesirable contamination of water or other material in which it may be detected. This has been, and still is, a much vexed question. Not many years ago the mere presence of this micro-organism in (say) a suspected water sufficed in the opinion of not a few bacteriologists to condemn such water as a source of public supply. As time went on, the abundance or the reverse of B. coli in water samples came to be, in no small degree as a result of representations by Dr. Houston, judged a better criterion of the antecedents of such water than the mere presence of this micro-organism; and later still the ratio of B. coli to total micro-organisms of all kinds in a given sample of suspected material, water or other, became admittedly a consideration of definite importance. Now, however, we are learning, again through Dr. Houston, that the human intestine furnishes at one and the same time definite and indefinite forms of B. coli; and that therefore classification of coli-like microbes present together in (say) water, plus estimation of the number of micro-organisms in each class, is likely to be found, quâ the B. coli test, the all-important consideration. That, for instance, given a material definitely contaminated with excrement and containing therefore B. coli in abundance, the ratio in such material of typical B. coli to total coli-like microbes may serve to indicate with a precision not hitherto attained the degree and the nearness or remoteness of fæcal contamination of the material in question.

On the above basis of comparison—*i.e.*, greater or less abundance of coli-like microbes and predominance or otherwise of typical over atypical coli,—the facts recorded by Dr. Houston in this and in preceding reports of your Medical Officer respecting the biological qualities of the excrement of beasts, birds and fishes, and of soil and water, must needs appeal alike to the student of natural history interested in the influence of environment on living organic matter, and to the sanitary administrator whose business it is to secure for the community water supply free from dangerous excremental contamination.

In Appendix C, Dr. Alan Green reports further observation on chloroformed calf vaccine. Seeking always to perfect his chloroform process of preparation of lymph, Dr. Green has made a number of experiments on the effect of temperature in expediting or in delaying the germicidal action of chloroform, not only on harmless micro-organisms such as are commonly associated with calf vaccine, but also on certain pathogenic microbes which, though foreign to calf lymph, might possibly

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on occasion gain access thereto. He finds the most satisfactory temperature at which to conduct his process in elimination from lymph of non-sporing extraneous micro-organisms to be 20° C. Thus, dealing by his method with a considerable variety of bacteria, non-pathogenic and pathogenic, these micro-organisms, indifferently whether submitted to chloroform in culture emulsion or mixed with vaccine lymph, were, he ascertained, killed always within eight hours of commencement of experiment.

As to the trustworthiness of chloroformed lymph in producing vaccinia in the human subject, Dr. Green notes that of 65,735 vaccinations performed with lymph thus prepared by him, above 98 per cent. were successful, and that the "insertion success" obtained exceeded 94 per cent. Inasmuch as the lymph serving for the above vaccinations was issued on the average not more than 17 days after collection from the calf, it is obvious that in Dr. Green's chloroform process the Board have obtained a useful means of increasing at comparatively short notice their output of trustworthy lymph, a circumstance of no small importance in the event of sudden and extra demand for vaccination arising on account of epidemic small-pox.

I have the honour to be,

Sir,

Your obedient Servant,

W. H. POWER.

APPENDICES.

APPENDIX A.

No. 1.

PARIS SANITARY CONFERENCE.—REPORT of BRITISH DELEGATES to the MARQUESS OF LANSDOWNE.

Paris, January 20th, 1904.

MY LORD,

IN previous despatches we have endeavoured to keep your Lordship informed of the proceedings of the International Sanitary Conference, which culminated in the signature on the 3rd December, 1903, of a new Sanitary Convention.

It is perhaps fitting that we should submit to your Lordship in a final despatch a general statement of the results obtained, and of our attitude with regard to the various questions dealt with.

The Conference was attended by delegations from the following twenty-three States:—Germany, Argentine Republic, Austria-Hungary, Belgium, Brazil, Denmark, Spain, United States, France, the United Kingdom, Greece, Italy, Luxemburg, Montenegro, the Netherlands, Persia, Portugal, Roumania, Russia, Servia, Sweden and Norway, Switzerland, and Turkey. In the British delegation India, and in the Turkish delegation Egypt, were represented by separate Delegates. With few exceptions every State was represented by both diplomatic and technical delegates.

The opening meeting of the Conference was held on the 10th October, and the closing meeting, at which the Convention was signed, took place on the 3rd December. In all seven plenary meetings were held; but the detailed work of the Conference was done in Committee. Three Committees were appointed, and it will be most convenient to discuss the different questions as near as may be in the order in which they were dealt with by those Committees.

The three Committees were:—

(A.) The Ways and Means Committee.

(B.) The Technical Committee.

(C.) The Codification Committee.

(A.)—QUESTIONS DEALT WITH BY THE WAYS AND MEANS COMMITTEE.

1. *The Constantinople Board of Health.*

The need for reorganizing this body was admitted by all the delegations, with the exception of the Turkish. The proposals

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that the Turkish members should be reduced to four; that the two Inspectors should be named by the Board itself; that Roumania should be represented on the Board; that the non-Ottoman Delegates should fulfil certain conditions as to nationality, medical qualification, or Vice-Consular rank; and that the decisions of the Board should be binding on the Ottoman Government, were accepted almost with unanimity. The Turkish delegation, however, declined even to discuss, much less to accept, any of these various proposals.

In regard to our own attitude on this question, we fully shared the general opinion as to the need for reforms, and we accepted without reserve the above proposals, save that, in respect of the last, we maintained the view always held by His Majesty Government that the Constantinople Board of Health is an Ottoman institution, and that the Ottoman Government is ultimately responsible for the measures that may be taken in the sanitary defence of the Turkish Empire.

2. *The Tangier Sanitary Board.*

We were able to associate ourselves unreservedly with the following "vœux" expressed by the Conference:—That the Tangier Board should apply the provisions of the International Sanitary Conventions; that the Morocco pilgrimage should be properly supervised; and that a lazaret should be established in a suitable spot near Tangier, as, for example, at Malabata.

3. *The Red Sea, Suez Canal, and the Egyptian Quarantine Board.*

A proposal was made by the Egyptian Delegates, and supported by us, that the medical inspection at Suez of ships wishing to pass through the Canal should be allowed to take place by night as well as by day. This proposal was accepted as regards ships lighted by electricity, and also as regards any ship that the local sanitary authority may consider sufficiently well lighted.

The Regulation providing that, in countries outside Europe, persons leaving an infected port must be medically examined by day and on shore, was modified as regards Alexandria and Port Said. At these ports, first-class and second-class (but not third-class) passengers may now be examined by night as well as by day; and the examination may also be conducted on board, provided that the third-class passengers do not subsequently leave the ship.

The Egyptian delegation further proposed that pilgrim ships from Hedjaz should henceforth be allowed to transit the Canal without a preliminary detention at Tor. This proposal, however, met with opposition, and was therefore withdrawn. It was revived, in a slightly modified form, by the Russian delegation, but was

again rejected. Ultimately it was agreed that pilgrim ships belonging to those nations which shall have accepted the present and the previous Conventions shall be allowed to transit the Canal without detention at Tor, if they fulfil certain conditions. These conditions are stated at length in Article CXLIII. of the Convention.

Two proposals were made respecting the powers and attributions of the Egyptian Maritime, Sanitary, and Quarantine Board. The first was made by the Italian delegation, and was to the effect that the Board should cease to have any concern with the internal sanitary affairs of Egypt, and that these should be left entirely to the Government of His Highness the Khedive. The second was made by the Egyptian delegation, and was to the effect that both the internal and external sanitary control of Egypt should be confided to one Government body, the International Board of Egypt confining itself to the task of furnishing information to the European Governments on the course of sanitary affairs in those regions. We supported both proposals, but both were rejected, and no alteration has been made in the powers or attributions of the Board.

We should here call your lordship's attention to the unanimous and warm tribute paid by the Conference to Dr. Ruffer, for his conduct of affairs as President of that Board.

The Egyptian delegation further proposed that the passage by train of mails and passengers from contaminated countries should be permitted across Egypt, under conditions which had already been submitted to the Egyptian Quarantine Board, and which were repeated to the Conference. This proposal was accepted by the Conference, and the regulation for the transit of Egypt in quarantine by train forms Annexe 1 of the new Convention.

4. *The Sanitary Defence of the Persian Gulf.*

The decisions on this question are a repetition of those of the Venice Sanitary Convention of 1897, with certain modifications and additions. They are, as before, grouped under two headings —the sanitary régime to be applied, and the sanitary posts to be established, in the Gulf.

The régime in the Gulf has been modified by a reduction from ten to five days in the period of observation in the case of suspected ships, and in the length of voyage from an infected port, after which a healthy ship shall be entitled to free pratique. We should also note that the Conference has recognized that a sanitary service now exists at Bushire. The clause in the Convention permitting ships to operate there no longer contains the words "lorsqu'une installation sanitaire convenable y aura été établie."

With regard to the sanitary posts to be established in the Gulf, the decisions of the Venice Convention have been modified in the following manner:—The new Convention provides, as did the

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former one, for two lazarets : one at the entrance of the Gulf and one in the neighbourhood of Bussorah. But the Island of Ormuz is now definitely named as the site of the former. The Constantinople Board of Health is given the same powers over the Ormuz lazaret as over that at Bussorah. It is further charged with finding the funds needed for its installation, and it is added that the Mixed Commission for the Revision of the Sanitary Tariff should meet as soon as possible, to authorize the advance of the funds from the Board's reserves.

We would point out here that in the Article giving the Constantinople Board authority to establish and control the Ormuz lazaret, the clause contained in the former Convention—"Pour la station d'Ormuz une entente sera établie entre le Gouvernement Ottoman et le Gouvernement Persan"—has been suppressed. That "entente" had, it was thought, been arrived at in the interval between the two Conventions, Persia not objecting to the lazaret being built and controlled, and its staff named, by the Constantinople Board, provided that the flag and the armed guards were Persian. But this view was shown to be incorrect by the unqualified declaration of the Turkish delegation, at the fifth plenary meeting, that no such "entente" existed, and that Turkey regarded the proposal that the lazaret should fly the Persian flag as inadmissible. The second part of that declaration called forth an energetic protest from the Persian delegation.

Our attitude on these various points was based on the following considerations :—

The proposals to establish lazarets at (or near) Ormuz and Bussorah constructed and controlled by the Constantinople Board were accepted by Her Majesty's Government at the Venice Conference of 1897.

On the purely sanitary side of the question, we were of opinion that the need for a lazaret at the entrance to the Gulf had not been demonstrated. On the contrary, the experience of the last seven years has shown that the absence of such a lazaret has not, as it was feared it would, proved a danger, and that, though plague and cholera have repeatedly been introduced to the Gulf shores, they have not extended beyond those shores and invaded Europe. The disastrous experience which followed the opening of the Adjir lazaret—the only one as yet opened in those regions—was also fresh in our minds, as an object lesson of the extreme unsuitability of the climatic and other conditions for a lazaret in those waters, and of the danger of establishing an institution of the kind so far away from the centres from which it must be controlled.

Your Lordship's final instructions authorised our acceptance of the proposals, but subject to certain conditions. At the sixth plenary meeting of the Conference we stated that we accepted the proposals, but at the same time we dwelt on the considerations enumerated above as militating against the construction of the Ormuz lazaret, and added that we should prefer to see the time and money spent in perfecting the Bussorah lazaret. At the final

meeting, before signing the Convention, we made the following reserves, as conditions to which our acceptance of the proposed lazaret was subject :—

1. That the decisions of the Mixed Commission concerning the advance of funds for its construction must be unanimous ; and

2. That no steps should be taken for its construction until the Constantinople Board of Health shall have been reorganized in the manner agreed on by the present Conference.

On the question of the reunion of the Mixed Commission, we repeated the condition under which His Majesty's Government has already consented to its reunion, namely, that the Commission should put in a prominent position in its programme the possibility of reducing the sanitary dues in Turkish ports.

5. *International Health Bureau.*

A proposal to establish a central office, under international management, to collect and publish information on the course of epidemic diseases all the world over, was first made by the International Sanitary Conference held at Vienna in 1874, and the Austrian capital was then selected for its seat. That proposal was never carried out. It has been revived in a slightly modified form by France in the present Conference,and Paris has been proposed for its seat. The Bureau is intended to be organized on the model of the Weights and Measures Bureau, which also sits in Paris. M. Barrère, who introduced the proposal, was careful to state that the Bureau would be strictly international ; that, wherever it might be located, the local Government should exercise no controlling influence over it ; that its main object would be to collect and distribute information about epidemics and the measures taken to deal with them ; and to indicate from time to time where the measures decreed by the International Conventions seemed to require amendment ; and that it would in no way interfere with the sovereign rights of an infected country, or do more than exert a "moral" influence in regard to the sanitary measures taken in such country.

While, from a theoretical standpoint, this proposed institution had not a little to recommend it, there were important practical considerations which prevented us from giving it immediate and unreserved acceptance. So far as concerns the obtaining of information on the course of epidemics, the machinery already possessed by His Majesty's Government for the purpose is as efficient as, if not more efficient than, any machinery that could be set up by an International Bureau ; and it is very doubtful whether the Reports which the Bureau would issue from time to time would be any more complete than those published by the Local Government Board. The passage of information through an International Bureau would rather tend to delay than to facilitate its arrival to the Governments interested. So far as the United Kingdom was concerned, therefore, the proposed Bureau seemed to offer no

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advantage that she does not already possess. On the other hand, there are many countries which have not provided themselves with the same efficient machinery, and to these countries the Bureau's Reports would prove of value.

There is no doubt that the French delegation attached much importance to the proposed Bureau; and we were desirous to meet their wishes to the fullest extent possible, and to avoid any action that might appear in the least unfriendly. But our doubts as to the utility of the proposed Bureau were fully shared by the German and Austro-Hungarian delegations. We were of opinion that the proposal was one that could be better dealt with at leisure, by subsequent correspondence through the ordinary diplomatic channels, than by the rapid decisions of a Sanitary Conference. As the result of private conversations with members of the French delegation, and to meet the wishes not only of ourselves but also of our German and Austro-Hungarian colleagues, the clause concerning this matter was modified in such a manner as to bring about the above result. The decisions of the Ways and Means Commission as to the establishment and objects of this Bureau appear only as an Annex to the Convention, and the Article in the Convention itself merely states that the Conference having taken note ("ayant pris acte") of these decisions, the French Government "saisira, quand il le jugera opportun, de propositions à cet effet, par la voie diplomatique, les États représentés à la Conférence."

At the final meeting for signature of the Convention we briefly repeated the reserve we had already made in the Ways and Means Committee as to the unproved utility of the proposed Bureau.

(II.) Questions dealt with by the Technical Committee.

One of the first questions dealt with was the incubation period of the plague. That period had been fixed by the Venice Conference of 1897 at ten days. It has now been reduced to five days (largely owing to the evidence adduced and the conclusions arrived at by the Indian Plague Commission). The principal results of this reduction have been the following:—A reduction from twelve to seven days in the plague-free period which determines whether a ship is "infected" or only "suspected"; a reduction from ten to five days in the periods of observation or surveillance which are imposed, according to circumstances, on the various classes of ships, whether in Europe, in the Red Sea, or in the Persian Gulf; and a similar reduction in the period after the last case of plague at the expiry of which a contaminated area is to be regarded as clean.

The decision that no goods are in themselves capable of transmitting plague or cholera, and that they become dangerous only when actually contaminated with the products of those diseases, has led to results which we regard with satisfaction. Disinfection

can now be applied only to such goods as the local authority considers contaminated, and the list of articles formerly called "susceptibles," which may be disinfected or prohibited admission to a country, irrespective of whether they are contaminated or not, has been very greatly reduced.

The decision that plague is not spread by water has led to the removal from the Convention of all those clauses which formerly required the change of drinking water and the emptying of bilges in connection with plague on ship-board. These measures are still retained in connection with cholera.

The formal recognition that a plague patient is no longer dangerous from the moment he is isolated has put "isolation" on the same level with "cure" or "death" of a patient. This is to some extent a gain, as implying the earlier removal of measures after the occurrence of a plague case on shore. On the other hand, the decision that the adoption of measures should date from the isolation, and not from the occurrence, of a case is a disadvantage in connection with plague on ship-board.

The sections dealing with notification have been modified by the addition of clauses concerning rats (which we deal with later), and of a clause to the effect that a single case of plague or cholera, even when indigenous, is not to involve the application of measures by other countries. The proposal to make the "local area" (for purposes of notification) a large one in the case of cholera and a small one in the case of plague was rejected; and the only changes made in the definition of a local area ("circonscription") are the substitution of the words "une partie de territoire bien déterminée" for the words "une partie de territoire d'un pays placé sous une autorité administrative bien déterminée"; and the addition of "un quartier d'une ville" and "une agglomération" to the list of examples of local areas.

The classification of ships into "infected," "suspected," and "healthy" remains unaltered, save that in the case of plague the plague-free period which determines whether a ship is infected or suspected has been reduced from twelve to seven days. A formal proposal to base the classification of ships and the measures imposed on them, not on the state of health of the ship, but on that of the port of departure, was brought forward by the French delegation. This proposal we regarded as of a highly retrograde character, and it would, if carried, have reintroduced a system against which our predecessors had strongly and successfully fought in the earlier Conferences. It was opposed by ourselves and others, and no serious attempt was made to put it through.

The clause which allows the sanitary authority to take into consideration, in the application of measures, the presence of a doctor and a stove on a ship, remains as in the former Convention; and analogous clauses have now been added respecting the presence of an apparatus for rat-destruction and of a State-appointed doctor. We did not object to these additions. In regard to the question of State-appointed doctors, the preliminary

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speeches at the opening meetings of the Conference had seemed to foreshadow proposals to make it compulsory on all ships to carry such doctors. No such proposals were, however, made: and we do not think objection can be taken to the principle that the presence of such doctors on board may be taken into consideration in imposing measures on healthy ships, though we are aware that, with the rarest exceptions, British ships will not be in a condition to benefit by this clause.

The rôle of the rat in the spread of plague was for the first time discussed by the present Conference, and, as was foreseen, this question occupied a very prominent position in its deliberations.

A formal decision that "the rat is a danger in the spread of plague" was followed by the introduction into the Convention of a series of measures to meet this danger. These measures may be briefly summarized as follows:—

Rat plague on shore is not to be notifiable in the absence of human plague. A proposal to make it so notifiable was made, but rejected. In the presence of human plague on shore, rat plague, if existent, is to be notified at the same time as the human disease or soon afterwards, while, in the subseqnent reports on the progress of the epidemic, and at its end, the measures taken to control rat plague are also to be reported.

In the classification of ships as "infected," "suspected," and "healthy," human plague is alone to be taken into consideration. A proposal was made to put rat plague on the same level as the human disease for this purpose, but it was rejected. With regard to human plague on ships, rat-destruction is made compulsory on "infected" ships: it is recommended on "suspected" ships; it is facultative, but not to be applied as a general rule on "healthy" ships from infected ports.

With regard to rat plague on "healthy" ships, rat-destruction is compulsory on ships on board of which the presence of rat plague has been proved bacteriologically. It is applied, "if indeed necessary," on ships on board of which an unusual rat mortality has been observed.

The methods to be employed for rat-destruction were discussed at great length. The claims of the various gases hitherto tried for this purpose, and even of special machines for their application, were strongly advocated by different delegates. In the end, however, it was agreed—we think very rightly—not to recommend any individual method, much less any individual machine, for its application: and the final decision on this point was in the form of the following colourless assertion of facts:—

"In the present state of science the methods that have been recommended as the most effective for rat-destruction on ships are the following:

"1. A mixture of sulphurous and sulphuric anhydrides, sent into the hold under pressure.

"2. An incombustible mixture of carbon-monoxide and carbon-dioxide.

"3. Carbonic acid in the proportion of 30 per cent. of the air."

It was further recommended that, when not carried out by the sanitary authority, the operation of rat-destruction should be controlled by them, so as to assure the complete destruction of all rats on board; and it was decided that it may be done either before or after the discharge of cargo; that the process should be carried out so as not to injure the cargo, the engines or the walls of the ship; that in the case of infected or suspected ships the operation must not last longer than forty-eight hours, and in the case of healthy ships not longer than twenty-four hours; that in the case of ships in ballast it must be done as rapidly as possible, and always before loading. In the case of a healthy ship it is further laid down that the process is not to interfere with the circulation of passengers and crew between the ship and shore; and that if such a ship has once undergone the process, this is not to be repeated unless the ship has since brought up to the quays in an infected port, or the presence of sick or dead rats on board has been observed.

The clause which appeared in the former Conventions requiring Governments to provide and equip one port at least on each of their seaboards where a ship can be dealt with, whatever its sanitary state, is repeated in the new Convention. In this connection it is important to note that ships, even healthy ships, from infected ports have, under the old Conventions, been liable to repulsion to a properly-equipped port, to undergo the ordinary measures of disinfection. Rat-destruction has now been added to the measures for which such a ship may have to be repulsed. It was felt by ourselves and others that, while most large ports have the means of applying ordinary measures of disinfection, it might happen that only the single port, where it is made compulsory, would have the means for applying rat-destruction, and that some hardship might result, especially for healthy ships which were repulsed for this purpose. Clauses have therefore been added recommending that healthy ships should not be repulsed from large seaports, and providing that all ports open to arrivals from plague or cholera-infected ports must be provided with the means for applying rat-destruction as well as the ordinary sanitary measures. Countries will notify to each other the list of such ports.

We should add here that the present Conference has admitted the right of neighbouring countries to organise common sanitary stations. We accepted the principle, under the condition that, when carried into practice, it should not, by reducing the number of sanitary stations, cause loss to shipping.

With regard to the cost of rat-destruction on ship-board, it has been decided that, whether the measure be carried out by the sanitary authority or by a company or individual, the sum charged to the ship should be fixed by a tariff published in advance, and should be at a rate which will not result in a profit to the State or sanitary authority.

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Report of British Delegates to International Paris Sanitary Conference, 1903.

We have given at some length the above decisions concerning the danger from rats and the methods devised for meeting it. This matter has now come under international agreement for the first time. Before the Conference met we were not a little apprehensive that the measures which would be imposed to deal with rats would be unnecessarily onerous to shipping and commerce. There was, as a matter of fact, considerable divergence of opinion as to the exact degree of danger to be attributed to the rat, though all were agreed that this animal is a danger. Our own view throughout has been that the danger has been proved, that the degree of importance to be attached to it has never been determined, and that it may easily be exaggerated, and that in some countries it has been greatly exaggerated. While prepared to accept reasonable measures to deal with rat-plague when its presence has been proved, or even strongly suspected, we were opposed to indiscriminate rat-destruction in cases where the presence of rat plague was no more than a possibility.

Proposals for measures of the latter kind were made to the Conference, and it was our duty to combat them. We succeeded in obtaining a compromise, in which we think our views are, to a certain extent, met. We should have preferred to see less latitude left to a sanitary authority in the ordering of rat-destruction on a healthy ship from an infected port, in the repulsion of such a ship to another port for this purpose, and in the matter of the charge made to ships for rat-destruction. But no better results were attainable, and the whole group of rat measures as finally established is of a much less stringent character than we had originally feared it would be. Nor do we think, in regard to the three points just mentioned, that the results in practice will be so prejudicial to shipping or commerce as might at first sight appear probable. Thus, in the matter of the faculty left to sanitary authorities to destroy rats on healthy ships from an infected port, it is certain that in many instances the commercial rivalry between neighbouring ports will act as a restraint on port authorities in ordering indiscriminately a measure which might drive ships to other more indulgent ports.

In the matter of the repulsion of ships to other ports for rat-destruction, not only does the same (or an analogous) consideration hold good, but ships will in the future, as in the past, ascertain what are the fully-equipped ports, and will sail to them first, instead of going to other ports, only to court repulsion. Finally, in the matter of the charge to shipping for rat-destruction, we should have greatly preferred to see our own proposals accepted. These were that, when executed by the sanitary authority, the charge should not exceed the actual cost of the operation (not including the original cost of the plant); and that when done by a Company or an individual, the charge should be as low as possible, and should in no case exceed 300 fr.

The Representatives of Brazil and the Argentine Republic were desirous of introducing into the Convention detailed Regulations for the control of yellow fever. Colonel Gorgas, of the United

States delegation, read a very interesting Report upon the work done in America in establishing the rôle of the mosquito in the spread of the disease; and the Argentine Delegate submitted a draft set of Regulations based upon the mosquito theory. This was not, however, added to the Convention, which contains but a single Article (Article 182) concerning yellow fever. That Article recommends the countries interested to bring their Sanitary Regulations into line with the teaching of modern science, particularly in regard to the part played by the mosquito in spreading the disease.

(C.)—The Codification Committee.

The work of this Committee was almost exclusively confined to reducing to one, more or less consistent, document the four preceding Conventions of 1892, 1893, 1894, and 1897, and incorporating in it the additions and modifications made by the present Conference.

In this task, the preliminary work of M. Béco, the Belgian Delegate, in preparing editions of the earlier Conventions, first in parallel columns and then in a single, unified code, was of invaluable service.

The above summary includes all the more important points dealt with by the Paris Conference of 1903. In this summary we have not even attempted to mention every minute modification which has been made in the Sanitary Regulations previously in force under the old Conventions; but we may add that practically all those modifications result from the application of the principles accepted by the Conference, which we have enumerated above.

The resulting Convention substitutes a single consistent document for four complex and sometimes contradictory instruments. To Sanitary Administrators this result alone is a gain of no small magnitude. On the individual additions and modifications now introduced we have already expressed our opinion. Of the new Convention as a whole we would venture to say that if, on the one hand, it seems to impose certain sanitary measures which were not in force before, it offers, on the other hand, fresh advantages to shipping and commercial interests which were not offered by the former Conventions. We may briefly balance the gains and losses of the new Convention from the point of view of decrease or increase in restrictive measures, and the corresponding approximation or the reverse to the liberal views which have always been held by the United Kingdom on the prophylaxis of disease.

The "gains" from this point of view, must be held to include the following:—

The reduction in the incubation period of plague, with consequent marked reduction in the régime applied, both on ship and on shore, both in Europe and outside Europe, to deal with the disease.

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The recognition that no class of goods is itself "susceptible" of carrying infection, and the consequent reduction in the list of goods which may be disinfected or prohibited admission to a country.

The notification of a first case of plague or cholera, even when indigenous, not to involve the application of measures.

The end of an epidemic to date from the isolation, when isolation has been effected, instead of from the death or cure of the last patient.

The decision that plague is not spread by water, and the consequent removal of certain measures on ships intended to meet the supposed danger.

The acceptance of the medical visit at night for ships passing the Suez Canal.

Pilgrim ships belonging to nations that have accepted the Conventions to be allowed, under certain specified conditions, to transit the Canal without preliminary detention at Tor.

The acceptance in principle, of the transit of Egypt in train, *en contumace*, by passengers and mails from the East.

The "losses"—or apparent losses—on the other hand, are principally those connected with the danger from rats. In practice, however, we are far from sure that the new Regulations to meet this danger are to be regarded as "losses," in the sense of adding new restrictions to shipping. The matter was not dealt with in any way by the old Conventions, and, consequently, many countries considered themselves free to impose almost any measure they thought fit to deal with rats. The result was a complete lack of uniformity, and entire uncertainty in the measures to which any ship was liable; and in some countries the measures actually imposed were excessively stringent. The new Convention has at least introduced the elements of uniformity and certainty. It has further established a maximum of rat measures, with a consequent power to claim compensation if a port authority exceeds that maximum. As we had the honour to point out in an earlier Report, we think this maximum is placed too high, but we may repeat that it is much lower than we had anticipated, much lower than was proposed to the Conference, and lower than was actually in practice in some countries. In those countries British shipping is therefore a gainer, and not a loser, under the new Convention. In all countries shipping is a gainer, in that the new Convention lays down conditions which must be observed in applying rat-destruction—conditions which were often not observed in practice before.

Thus, it is now established that the process must not cause damage to the cargo, the engines, or the vessel itself; that it must not last more than twenty-four hours in some cases, forty-eight hours in others, and that, in the case of a healthy ship, it is not to be done as a general rule, nor to interfere with the circulation of passengers or crew from ship to shore; and is not to be unnecessarily repeated.

The Convention was signed on the 3rd December by the Representatives of twenty-one States. The following is a list of the Signatory States :—

*Germany.	Luxemburg.
Argentine Republic.	Montenegro.
*Austria-Hungary.	*Netherlands.
Belgium.	Persia.
Brazil.	Portugal.
Spain.	Roumania.
*United States.	Russia.
France.	Servia.
*United Kingdom.	Switzerland.
Greece.	*Egypt.
Italy.	

The States whose names is marked with an asterisk (*) signed under the reserves which will be mentioned later.

The Representatives of Portugal, Greece, Persia, Egypt, Brazil, the United States, and Servia signed *ad referendum*.

The Representatives of Sweden and Norway and of Denmark did not sign the Convention.

The Turkish delegation stated that they were authorised to sign, but under so many reserves that these would have practically annulled the whole Convention. Under these circumstances the President of the Conference stated that he could not accept their signature.

We should add that it was unanimously agreed (with the exception of the Turkish delegation) that the States represented at the Conference should use their best endeavours to induce Turkey to accept and apply the International Sanitary Conventions.

The following is a brief summary of the reserves under which certain Powers, as stated above, accepted the Convention :—

Reserves of the United Kingdom.

1. As to the unproved utility of the proposed International Bureau.

2. In regard to the proposed sanitary station at the entrance to the Persian Gulf. There were three reserves on this point :—

(*a.*) That the consent of His Majesty's Government to the reunion of the Mixed Commission for the Revision of the Turkish Sanitary Tariff (one object of which would be to authorise the advance of funds for that station) is subject to the condition that the Commission shall put in a prominent position in its programme the possibility of reducing the sanitary dues in Turkish ports.

(*b.*) That the decisions of that Commission, when voting funds for this purpose, must be unanimous,

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(*c.*) That no steps shall be taken for the construction of the station in question until the Constantinople Board of Health shall have been reorganized in the manner agreed upon by the present Conference.

The British delegation further supported the "vœu" of the German delegation respecting the cost of rat-destruction on ships.

Reserves of Germany.

1. A "vœu" that when rat-destruction is carried out by a Company or an individual, the charge made to the ship shall not be excessive.

2. A reserve, of minor importance, respecting the disinfection of certain objects.

3. As to the unproved utility of the proposed International Health Bureau.

Reserve of Austria-Hungary.

As to the unproved utility of the proposed International Health Bureau.

Reserve of the United States.

As to the substitution of "surveillance" for "observation," on account of special legislation in the different States of the Union.

Reserve of the Netherlands.

The Netherlands reserves the right to name as Delegate to the Constantinople Board of Health either a medical man with a Dutch qualification or a Consular official of the rank of Vice-Consul at least, whatever may be the country he represents or the nationality to which he belongs. It is in the words underlined that this reserve differs from Article CLXIX. of the Convention, which is ambiguously worded in more than one respect.

Reserve of Egypt.

Egypt is unable to accept Article CLXIII. of the Convention respecting the annual contribution by the Egyptian Government of £4,000 towards the increased cost of the staff under the Alexandria Quarantine Board.

A gloom was cast over the last week of the Conference by the sudden illness and death of Professor Proust of the French delegation. The name of Professor Proust had been for so long associated with international sanitary work, and he had always

taken such an active, prominent, and valuable part in the preceding, as in the present, Conferences, that his death was felt as a loss, not merely to France, but to the whole world of sanitary workers. All the delegations attended his funeral, which was a public one, and the message of condolence and sympathy which we had the honour to communicate to the Conference by your Lordship's instructions was warmly appreciated by the President and other members of the French delegation.

We desire, in conclusion, to pay a sincere and deserved tribute to the French Government for the hospitable manner in which we, as all the foreign delegations, were received and entertained, collectively and individually. We were most courteously received by M. Loubet, President of the Republic, at the Élysée, and we were more than once the guests of M. Delcassé, who honoured us with invitations to some of the entertainments given at the time of the visit of the King and Queen of Italy to Paris. At other times we were the guests of M. Barrère, the President of the Conference, of M. Monod, and of the Paris Municipality.

We have, &c.,

(Signed) M. DE BUNSEN.
T. THOMSON.
F. G. CLEMOW.
A. D. ALBAN.
J. RICHARDSON.

No. 2.

APP. A. No. 2.
Summary of the Work of the Medical Inspectors in 1903.

*SUMMARY of the WORK of the MEDICAL INSPECTORS during the YEAR 1903.

A. DISEASE AND SANITARY ADMINISTRATION.

The following sanitary districts were visited by the Medical Inspectors with special reference to outbreaks of infectious disease of one and another sort, and to general sanitary circumstances and administration, viz. :—

Name of District.	Nature of Inquiry.
Abram, U.D.	Sanitary administration with reference to small-pox.
†Acton, U.D.	Enteric fever.
Ashton-in-Makerfield, U.D.	Sanitary administration with reference to small-pox.
Ashton-under-Lyne, U.D.	Do. do.
Aspull, U.D.	Do. do.
Barrow-on-Soar, R.D.	Do. do.
Basford, R.D.	Do. do.
Billinge, U.D.	Do. do.
Blackrod, U.D.	Do. do.
Bromley, R.D.	Enteric fever at Mottingham.
†Bromley, R.D.	Sanitary state and administration of parish of West Wickham.
Burnley, U.D.	Sanitary administration with reference to small-pox.
Burslem, U.D.	Do. do.
Connah's Quay, U.D.	Do. do
Crompton, U.D.	Do do.
†Denbigh, U.D.	Diphtheria.

* Throughout this summary the following abbreviations are used :—U.D. = a Borough or Urban District ; R.D. = Rural District ; P.S.D. = Port Sanitary District ; Jt.H.D. = A Joint District for hospital purposes, formed under the Public Health Act, 1875, or the Isolation Hospitals Acts, 1893 and 1901.

† *See* Appendix A, No. 3, p. 24.

‡ The reports on these districts are reproduced in full in this volume, *see* Appendix A, Nos. 5 to 8.

A. Disease and Sanitary Administration—*continued.*

Name of District.	Nature of Inquiry.
†Ealing, U.D.	Enteric fever.
Ealing, U.D.	Sanitary administration with reference to small-pox.
†East Ham, U.D.	Sanitary state and administration.
†Ellesmere, R.D.	Cerebro-spinal meningitis.
Halifax, U.D.	Sanitary administration with reference to small-pox.
Hanley, U.D.	Do. do.
‡†Hendon, U.D.	Epidemic skin disease at the Central London Sick Asylum.
Hindley, U.D.	Sanitary administration with reference to small-pox.
Holyhead, U.D.	Do. do.
Hucknall Torkard, U.D.	Do. do.
Ince-in-Makerfield, U.D.	Do. do.
†Itchen, U.D.	Enteric fever; sanitary state and administration.
Lambeth, U.D.	Small-pox at Rowton House, Vauxhall.
Leicester, U.D.	Sanitary administration with reference to small-pox.
Macclesfield, R.D.	Do. do.
Newtown and Llanllwchaiarn, U.D. ...	Do. do.
Nottingham, U.D.	Do. do.
†Oldbury, U.D.	Scarlatina.
Oldham, U.D.	Sanitary administration with reference to small-pox.
Orrell, U.D.	Do. do.
†Oswestry, U.D.	Cerebro-spinal meningitis.
Pemberton, U.D.	Sanitary administration with reference to small-pox.
Rochdale, U.D.	Do. do.
†Romford, R.D.	Diphtheria; sanitary state and administration.
†Sevenoaks, R.D.	Diphtheria at Kemsing.
Sowerby Bridge, U.D.	Sanitary administration with reference to small-pox.
‡†Spennymoor, U.D.	Sanitary state and administration.
Standish-with-Langtree, U.D.	Sanitary administration with reference to small-pox.

† *See* Appendix A, No. 3, p. 24.

‡ The reports on these districts are reproduced in full in this volume, *see* Appendix A, Nos. 5 to 8.

A. No. 2

nary of Work of Medical ctors in

A. Disease and Sanitary Administration—*continued.*

Name of District.	Nature of Inquiry.
Stockport, U.D.	Sanitary administration with reference to small-pox.
Stoke-upon-Trent, U.D.	Do. do.
†Thorne, R.D.	Sanitary state and administration.
†Towcester, R.D.	Scarlatina at Weedon Lois and Weston.
‡†Tyldesley-with-Shakerley, U.D.	Enteric fever; sanitary state and administration.
Upholland, U.D.	Sanitary administration with reference to small-pox.
Warrington, U.D.	Do. do.
‡†Whitehaven, U.D.	Sanitary state and administration.
†Whittlesey, R.D.	Do. do.
†Whittlesey, U.D.	Do. do.
Wigan, R.D.	Sanitary administration with reference to small-pox.
Wigan, U.D.	Do. do.
Woolwich, U.D.	Enteric fever at Eltham.
Workington, U.D.	Sanitary administration with reference to small-pox.
†Wrexham, R.D.	Sanitary state and administration.

B. Hospitals, &c.

Local inquiries were held by the Medical Inspectors with reference to the provision of hospital accommodation for the isolation of cases of infectious disease in connection with the following districts:—

Ampthill, R.D.
Ashbourne, Jt.H.D.
Ashton-under-Lyne, U.D.
Auckland, Shildon, and Willington, Jt.H.D.
Barking Town, U.D.
Barnes, U.D.
Barnet, Jt.H.D.
Barnsley, U.D.
Benwell and Fenham, U.D.
Biggleswade, Jt.H.D.
Birkdale, U.D.
Braintree, Jt.H.D.
Bridport, R.D. and U.D.
Burnley, Jt.H.D.
Burslem, U.D.
Bury and District, Jt.H.D.
Canterbury, U.D.
Cheshunt, U.D.
Chester-le-Street, R.D.

† *See* Appendix A, No. 3, p. 24.
‡ The reports on these districts are reproduced in full in this volume, *see* Appendix A, Nos. 5 to 8.

B. HOSPITALS, &c.—*continued*

Cirencester, R.D.
Clacton, U.D.
Colchester, U.D.
Darlington, U.D.
Dartford, Jt.H.D.
Devizes, Jt.H.D.
Dover, U.D.
Earsdon, Jt.H.D.
Eton, R.D.
Farnham, Jt.H.D. (2).
Frinley, U.D.
Great Ouseburn, Jt.H.D.
Guildford, Godalming, and Woking, Jt.H.D. (2).
Hambledon, R.D.
Hanley, Stoke, and Fenton, Jt.H.D. (2).
Harrogate and Knaresborough, Jt.H.D.
Haslingden, U.D.
Hastings, U.D.
Henley and Wallingford, Jt.H.D.
Hertford and Ware, Jt.H.D.
Highworth, R.D.
Hitchin, Jt.H.D.
Hyde, U.D.
King's Norton and Northfield, U.D.
Leicestershire, Jt.H.D.
Leigh, Jt.H.D.
Leyton, U.D. (2).
Lincoln, U.D.
Linslade, U.D.
Littleborough, Wardle, and Milnrow, Jt.H.D.
Liverpool, U.D.
Manchester, U.D.
Melton and Belvoir, Jt.H.D.
Nantwich, Jt.H.D. (2).
Nelson, U.D.
Newark, U.D.
Newhaven, U.D.
Newtown and Llanllwchaiarn, U.D.
Normanton and District, Jt.H.D.
Northallerton, R.D. and U.D.
North Derbyshire, Jt.H.D.
North Staffordshire, Jt.H.D.(2).
Nottingham, U.D.
Ogmore and Garw, Jt.H.D.
Ormskirk, Lathom, and Burscough, Jt.H.D.
Orsett, Jt.H.D.
Oswestry, U.D.
Penarth, U.D.
Portsmouth, U.D.
Reading, U.D.
Rhyl, U.D.
Rochester and Chatham, Jt.H.D.
Rotherham, U.D.
Runcorn, R.D.
St. Helens, (Lancs.), U.D.
Salford, U.D.
Scarborough, U.D.
Selby, Jt.H.D.
Sevenoaks, R.D. (2).
Sheffield, U.D.
Sittingbourne and Milton, Jt.H.D.
Southall-Norwood, U.D. (2).
South Shields Rural and Southwick-on-Wear, Jt.H.D.
South Shields, R.D.
South Staffordshire, Jt.H.D.
Tarvin, Malpas, and Tarporley, Jt.H.D.
Ticehurst, R.D.
Trowbridge and District, Jt.H.D.
Upton-on-Severn, R.D.
Wakefield and District, Jt.H.D.
Wakefield, U.D.
Wallingford and Crowmarsh, Jt.H.D.
Waltham, Jt.H.D. (2).
Wanstead, U.D.
Warwick, Jt.H.D.
Watford, Jt.H.D.
Wath, Swinton, Greasborough, and North Rotherham, Jt.H.D.
West Bromwich, U.D.
West Ham, U.D.
West Hartlepool, U.D.
Whitstable, U.D.
Wigan and District, Jt.H.D.
Willesden, U.D.
Wing, R.D.
Wirral, Jt.H.D.
Withington, U.D.

B. HOSPITALS, &c —*continued.*

Inquiries were held as to the provision of mortuary accommodation for Guildford, U.D., and Hanwell, U.D.; of a doctor's room at the mortuary for Surbiton, U.D.; of *post-mortem* rooms for Greenwich and Guildford, U.D.; of disinfecting apparatus for Bedford, U.D., and Burslem, U.D.; and of a temporary shelter to accommodate persons during the disinfection of their dwellings for Battersea.

An inquiry was also held as to the issue of a provisional order divesting Hartlepool, P.S.D., of its powers as a Joint Hospital District.

C. SEWERAGE AND SEWAGE DISPOSAL.

Inquiries in this connection were held as follows :—

Andover, R.D.	East Kerrier, R.D.

D. BYELAWS.

Inquiries with reference to byelaws were held as follows :—

Christchurch, R.D.	Stroud, R.D.
Ringwood, R.D.	

E. VACCINATION INSPECTION.

In addition to the routine inspection of vaccination in England and Wales (App. A. No.), special visits by Medical Inspectors with reference to vaccination administration were made to the Unions mentioned below. The visits to those Unions indicated in italics were made owing to the prevalence of small-pox in the Union :—

Ashton-under-Lyne.	*Newtown and Llanidloes.*
Barnsley.	Northampton.
Barrow-in-Furness.	*Nottingham.*
Basford.	*Oldham.*
Brentford.	Richmond (Surrey).
Burnley.	*Rochdale.*
Camberwell.	St. Pancras.
Cockermouth.	*Stockport.*
Croydon.	*Sunderland.*
Hackney (2).	Tewkesbury.
Halifax (2).	Wandsworth and Clapham.
Haltwhistle.	*Warrington.*
Hoylake.	Watlington.
Holywell.	Wellingborough.
Keighley.	Wigan.
Leicester.	*Wimborne and Boscastle.*
Newark.	

F. PLAGUE PRECAUTIONS.

Cases of suspected plague were locally investigated in :—

London, P.S.D. (2). | Swindon, U.D.

G. CONFERENCES WITH LOCAL OFFICIALS.

Conferences on sanitary matters were held locally with various officials of the following districts :—

Meriden, R.D. | Whitehaven, U.D.

H. MISCELLANEOUS.

Dr. Thomson represented the Board as one of the British delegates at the International Sanitary Conference held at Paris as to plague and cholera, and also at the International Congress of Hygiene and Demography at Brussels. He also held an inquiry into a proposal to extend the powers of the London Port Sanitary Authority to the wharves situated in the River Thames, more especially with reference to the inspection of imported food products landed at these wharves.

Dr. Sweeting visited Gloucester, U.D., as to an alleged death from small-pox which was not notified to the Medical Officer of Health ; and Dr. Copeman visited Cambridge, U.D., to advise as to differences that had arisen concerning the diagnosis of cases of small-pox presenting unusual features.

Dr. Bulstrode has continued his general inquiries into sanatoria for consumptives, and into oyster and other shell-fish layings with reference to their liability to pollution by sewage. He also held an inquiry at East Cowes, U.D., concerning an improvement of the foreshore and the raising of the causeway near the Medina Hotel. Dr. Bulstrode, in addition, inquired into preservatives in potted shrimps at Southport, U.D.

Dr. Reece held an inquiry as to the issue of a provisional order providing for the representation of and contribution from Ellesmere Port and Whitby, U.D., to the Manchester Port Sanitary Authority. He also inquired into a proposal of the Board of Customs to establish duplicate boarding stations for infected and non-infected vessels at the different Customs Ports in England and Wales.

Dr. Buchanan visited Faversham, P.S.D., to ascertain the facts as to coastguard, customs, and port officers' procedures with reference to vessels, foreign and coastwise, arriving in Faversham and Milton Creeks. He also inquired into the nature and extent of the discharges of alleged polluting liquids from the gunpowder factory at Waltham Holy Cross into Cobbin's Brook, a tributary of the River Lea.

APP. A, No. 2.

Summary of the Work of the Medical Inspectors in 1903.

Dr. Wheaton was associated with an engineering inspector in an inquiry at Colne, U.D., as to the issue of a provisional order to amend the Colne Corporation Act, 1897, as regards closet accommodation and receptacles for ashes and refuse. Inquiries into the administration with reference to privy reconstruction under local acts were held at Stockport, U.D., Sunderland, U.D., and West Bromwich, U.D., by Drs. Johnstone, Manby, and Mair respectively.

Dr. Manby conferred with the local authorities at Halifax, U.D., and Rochdale, U.D., as to regulations under Article 13 of the Dairies, Cow-sheds, and Milk-shops Order of 1885.

I. Inquiries by the Assistant Inspector in the Medical Department.

Mr. Huddart inquired into the arrangements for the discharge of the duties of Inspectors of Nuisances in the following districts :—

Ashbourne, R.D.
Atcham, R.D. (2).
Bakewell, R.D.
Barmouth, U.D.
Brandon, R.D.
Brecon, U.D.
Caxton and Arrington, R.D.
Chipping Sodbury, R.D.
East Ellloe, R.D.
Ellesmere, R.D.
Frome, R.D.
Grimsby, R.D.
Hendon, R.D.
Hertford, U.D.
Howden, R.D.
Isle of Wight, R.D.
Jarrow, U.D.
Llandovery, R.D.
Loughborough, R.D.
Lutterworth, R.D.
Monk's Kirby, R.D.
Nantwich, R.D.
Norman Cross, R.D.
North Bromsgrove, U.D.
Oakengates, U.D.
Overton, R.D.
Penybont, R.D.
Romford, U.D.
Shardlow, R.D.
Staines, R.D.
Thetford, R.D.
Trowbridge, U.D.
Wayland, R.D.

Mr. Huddart also visited the Unions named below as to the administration of the Vaccination Acts, and especially as to the performance of duty by Vaccination Officers :—

Abingdon.
Ashton-under-Lyne.
Auckland.
Axbridge.
Banbury.
Barton-upon-Irwell (3).
Bedford.
Beverley.
Bourne.
Bridlington.

I. INQUIRIES BY ASSISTANT INSPECTOR—*continued.*

Clitheroe.
Cockermouth
Croydon.
Dore.
Epsom.
Faringdon.
Gateshead (2).
Gloucester.
Godstone.
Halifax.
Haslingden.
Horncastle.
Keighley.
Keynsham.
Kington.
Lanchester.
Morpeth.
Mutford and Lothingland.
Reading.
Rochdale.
Rugby.
St. Thomas.
Scarborough.
Stroud.
Tewkesbury.
Walsall.
Warrington.
Wellington (Salop).
Weymouth.
Wortley.

No. 3.

APP. A, NO. 3. Extract of Medical Inspections.

ABSTRACT of MEDICAL INSPECTIONS made in 1903 with regard to the INCIDENCE of DISEASE on particular places, and to questions concerning LOCAL SANITARY ADMINISTRATION.

[*The reports relating to districts indicated by an asterisk are reproduced in this volume, see App. A, Nos. 5 to 8.*]

1. ACTON URBAN DISTRICT (MIDDLESEX): population, 37,744; Dr. Sweeting.

Authority concerned: Acton Urban District Council.

Ground of Inquiry: Prevalence of enteric fever.

Chief Facts reported by Inspector: Synchronous with an outbreak of enteric fever at Ealing, sudden increase at Acton in number of notifications of this disease. Of 16 cases notified between July 6th and August 13th, 11 had partaken of milk from the local depôt at Ealing of a certain Dairy Company. (*See* précis of Ealing report for details as to source and possible infection of this milk.)

Administrative measures same as at Ealing (q.v.).

2.* CENTRAL LONDON SICK ASYLUM, HENDON; Dr. Copeman.

Ground of Inquiry: Outbreak of epidemic skin disease.

Chief Facts reported by Inspector: In September, 1903, cases of skin disease, of similar character to those which in former years had come under observation in various Metropolitan Infirmaries, occurred in the Hendon Hospital of the Central London Sick Asylum District. Type of the disease less severe than in previous outbreaks—only two deaths among 68 persons attacked. As in former instances suspicion fell upon the milk supply, patients at once improving when put on Swiss milk. Samples of the milk remained sweet for several days even in hottest weather, raising presumption of addition of some preservative. This denied by contractor, but subsequent analysis showed presence in his milk of formalin.

DENBIGH BOROUGH (DENBIGH); population (1891), 6,439; Dr. Wheaton.

Authority concerned: Denbigh Town Council.

Ground of Inquiry: Continued prevalence of diphtheria, complaints of inefficient administration.

Chief Facts reported by Inspector: One case of diphtheria only in 1901; 205 cases in 1902, up to December 12th. The disease spread by attendance at school, especially at a particular school, the children attending which were, more than others, exposed to emanations from the sewers escaping into the school buildings. No hospital accommodation or disinfecting apparatus provided by the Town Council. The sewerage of the Borough extremely unsatisfactory, many catchpits in the course of the sewers containing decomposing filth, several sewers, including the main outfall sewer, blocked or partly blocked by deposit, flushing of sewers inadequate. Condition of dwellings in some parts of the Borough very unsatisfactory, house drainage often very defective, excrement disposal by water closets and by midden privies. Nuisances numerous.

EALING URBAN DISTRICT (MIDDLESEX); population (1901), 33,031; Dr. Sweeting.

Authority concerned: Ealing Town Council.

Ground of Inquiry: Prevalence of enteric fever.

Chief Facts reported by Inspector: Sudden increase in notifications of enteric fever. All the 23 attacks notified between July 25th and August 13th occurred among consumers of milk from the local depôt of a certain Dairy Company, supplied from a particular country farm. Other Ealing residents, partakers of this milk, attacked after leaving Ealing. Residents at Acton and Chiswick also partaking of the same milk contemporaneously attacked. On the country farm above referred to, a labourer had been attacked by enteric fever at about the same time that consumers of milk from this farm began to fall ill at Ealing. The cause of this man's illness not made out; he had opportunity of drinking from a polluted well. But no evidence was to be obtained as to the specific infection of this well, the water of which may have been used to wash milk-churns despatched to Ealing. Milk from the farm at once rejected by the Dairy Company, and pasteurised milk substituted.

Disinfection actively carried out by the Ealing Authority. No hospital isolation available locally for the majority of the cases.

5. EAST HAM (ESSEX); population (1901), 96,018; Dr. Fletcher.

Authority concerned: East Ham Urban District Council.

Ground of Inquiry: Doubful efficiency of sanitary administration under the present part-time Medical Officer of Health.

Chief Facts reported by Inspector: Increase of population from 10,706 persons at the census of 1881 to 95,018 persons at that of 1901, *i.e.*, in 20 years. Registrar-General's estimate of population at the time of inspection in 1903=112,000 persons. Water supply, from the East London Water Company, said to have been ample during the past two years. House accommodation fairly satisfactory. Scavenging and removal of house refuse well attended to; refuse dealt with at the sewage works; destructor in course of erection. House drains and sewers generally satisfactory. Sewage works inadequate, and treatment of sewage unsatisfactory. Hospital accommodation—two hospitals and laundry for infected things on three separate sites. A properly equipped hospital for all infectious diseases other than small-pox needed in place of the existing unsatisfactory arrangements. No proper steam disinfector in the district. Initiative in sanitary improvement referable less to the Medical Officer of Health than to the Chief Inspector of Nuisances.

6. ITCHEN URBAN DISTRICT (HANTS); population 13,000; Dr. Bulstrode.

Authority concerned: Itchen Urban District Council.

Ground of Inquiry: Complaints as to sanitary administration of District Council; continued prevalence of enteric fever.

Chief Facts reported by Inspector: Some of poorer house property neglected. Water supply partly from South Hants Water Company, partly from shallow wells. Part of district recently sewered, part unsewered. Sewers leaky and sewage disposal works not entirely satisfactory.

No proper isolation accommodation and no disinfecting apparatus. Disinfection practised with sulphur dioxide. Byelaws not always enforced. Records as regards prevalence of enteric fever indicative of encouragement of spread of the disease through want of proper isolation accommodation; repeated invasion of certain houses in successive years suggestive that such houses had never been properly disinfected. Public not taught to regard disease as communicable.

Need for provision by the District Council of proper facilities for isolation and disinfection, for examination of sewers as regards leakage, and for enforcement of byelaws. Thorough disinfection of invaded premises requisite.

7. KEMSING PARISH (KENT); population (1901), 644; Dr. Wheaton.

Authority concerned: Sevenoaks Rural District Council.

Ground of Inquiry: Prevalence of diphtheria; local complaints of inadequate measures taken to prevent the spread of the disease.

Chief Facts reported by Inspector: No diphtheria in 1901. In the next succeeding year and in 1903 up to April there occurred 75 cases with 8 deaths. At the commencement of the outbreak all the children attending the schools were found to be suffering from sore-throat more or less severely. The influence of school attendance in spreading definite diphtheria not very marked; in 18 instances persons attacked were above 12 years of age. In 19 instances more than one case occurred in the family, the carelessness of the inhabitants and their ignorance respecting the infectious character of the disease greatly conducing to its spread within doors. Condition of dwellings in many instances very unsatisfactory and their interiors very dirty and damp. No sewerage; house drainage often wanting; great difficulty in disposing of the contents of cesspools since the introduction of a public water supply. Isolation of the sick in a small iron chapel attempted but soon given up. Isolation of sufferers in the small cottages of the place practically impossible. No disinfecting apparatus in use.

8. OLDBURY URBAN DISTRICT (WORCESTERSHIRE); population (1901), 25,191; Dr. Bulstrode.

Authority concerned: Oldbury Urban District Council.

Ground of Inquiry: Prevalence of scarlatina.

Chief Facts reported by Inspector: During 1902 in a population of 25,600 there occurred 518 cases of scarlatina. The disease would appear to have been spread to some extent by school influence, or through the non-removal of cases from invaded houses. There had been no isolation of scarlatina in hospital.

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9. OSWESTRY BOROUGH AND ELLESMERE RURAL DISTRICT (SHROPSHIRE): population (1901), OSWESTRY, [illegible], ELLESMERE, 7,911: Dr. Reginald Farrar.

Authorities concerned: Oswestry Town Council and Ellesmere Rural District Council.

Ground of Inquiry: Prevalence in Oswestry and the village of Criftins of illness resembling epidemic cerebro-spinal meningitis, to which attention was drawn by Dr. Beresford, Medical Officer of Health, Oswestry Rural District.

Chief Facts reported by Inspector: During May 1903 an epidemic of illness resembling epidemic cerebro-spinal meningitis prevailed among the children of Criftins School. About 50 children were affected by the malady: there were about four cases of dangerous illness with two deaths, the rest of the cases being relatively mild.

The features of the current illness were acute febrile onset with headache and spinal pains, vomiting, delirium, furred tongue, and either diarrhœa or constipation. In certain of the cases herpes occurred, in several there were symptoms of pneumonia, and in a few paralytic symptoms.

A similar series of attacks occurred about the same time in Oswestry.

10. ROMFORD RURAL DISTRICT (ESSEX): population (1901), 29,123; Dr. Mivart.

Authority concerned: Romford Rural District Council.

Ground of Inquiry: Unusually large number of ratepayers' complaints. Long continued prevalence of diphtheria: insufficient reports concerning it from local Medical Officer of Health.

Chief Facts reported by Inspector: Enormous masses of manure imported for use in market gardens and fields. Water supplies, improved since previous inspections, now largely from South Essex Water Company. But a large number of houses still depending on shallow wells, especially in Rainham and Dagenham parishes, where the whole body of water in a bed of gravel overlying clay is practically contaminated by soakage of fæcal matter. Extension of sewage system since previous inspections, but Rainham and Dagenham still honeycombed with small cesspools constantly overflowing close [illegible] and even into dwellings. Rural District Council [illegible] until recently in refusing to undertake or to [illegible] for cesspool emptying, though accepting the [illegible] privy pails. Much deposit of refuse [illegible] slaughter-houses ill-kept. Dairies,

cowsheds, and milkshops in foul condition. Byelaws and regulations not enforced. Great prevalence of flies found infesting houses. During 1903 two outbreaks of diphtheria, with more than 200 cases; type rather severe. Diphtheria undoubtedly propagated by personal communication, especially in schools. Neglect to examine throats. Throat illness said to be very common; locality probably favourable to such. Insufficient preventive measures taken. Rural District Council have no disinfector of their own.

11.* SPENNYMOOR URBAN DISTRICT (DURHAM); population (1901), 16,383; Dr. Reece.

Authority concerned: Spennymoor Urban District Council.

Ground of Inquiry: Complaints by the Durham County Council under sections 15, 27, 36, 92–111, and 150, Public Health Act, 1875, in November, 1901, and under section 19 (2), Local Government Act, 1888, in October, 1902.

Chief Facts reported by Inspector: The district dealt with in reports by the Board's Medical Inspectors in 1874, 1884, 1885, 1889, and 1895. It was enlarged in 1894.

No complete system of sewers in the district and no efficient or comprehensive system of sewage disposal. These matters systematically neglected, the Sanitary Authority having declined when pressed, to take adequate steps to purify sewage. Sewage discharged in a crude state, or after subsidence only, into the tributaries of the River Wear at a number of points. Urban District Council recently appointed a miner, one of the Urban District Councillors, as Inspector of Nuisances, a man without practical experience of sanitary work and possessing no certificate of competency. Local Government Board refused sanction to appointment, but Inspector of Nuisances still continued in office by Urban District Council (July, 1904). Midden privies in need of constant supervision as regards scavenging; many of these, large, open middens of defective construction require to be abolished and replaced by others of suitable pattern. Byelaws as to common lodging houses not enforced. Dilapidated and structurally defective house property not effectively dealt with. Regulations for dairies, cowsheds, and milkshops not enforced. Slaughter-houses not properly supervised. The mortality of the district—infantile, from all causes, from fever, and from diarrhœa—exceptionally high as compared with the corresponding mortality of the County of Durham, or that of England and Wales. On an average of seven years ended 1902 uncertified deaths amounted to something just short of a quarter of the whole number of deaths registered. The sanitary requirements of the district

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duly set forth in his annual reports by Dr. Anderson, Medical Officer of Health, who has tendered well-considered advice for the guidance of the Urban District Council. The Council slack in taking advantage of the reports of their Medical Officer of Health. In erecting an isolation hospital out of borrowed money the plans, sanctioned by the Local Government Board after public inquiry, departed from and "undertakings" not observed.

12. THORNE RURAL DISTRICT (YORKSHIRE, WEST RIDING); population (1901), 7,246; Dr. Reece.

Authority concerned: Thorne Rural District Council

Ground of Inquiry: Complaints by the West Riding County Council under section 19 of the Local Government Act, 1888, in respect of the unwholesomeness of the existing water supply of the town of Thorne, in the Thorne Rural District. Failure of the Rural District Council to make any satisfactory reply to repeated reminders from the Local Government Board on this subject.

Chief Facts reported by Inspector: Water supply in question condemned by the Medical Officer of Health during nearly 20 years. Its dangerously polluted state set forth in 1883, 1886, and 1893 by the Local Government Board's Medical Inspectors, by the Medical Officer of Health, West Riding County Council, in 1891, and by his successor in 1900.

The main water supply for the town of Thorne from a navigable canal, which receives the refuse and the excremental discharges of a large floating population otherwise from shallow wells, liable to contamination from privies and middens, undrained cowsheds, and foul yards. These wells have been in many cases shown by analysis to be polluted. No satisfactory supply from lake, stream, river, or springs, being available, assistance was sought from H.M. Geological Survey. Mr. Fox-Strangeways of that Office visited the district with the Inspector, and reported that it was reasonable to suppose that thick bedded sandstones would be reached at a depth of 200 feet, or rather more, at or near Thorne, and that these strata might be expected to furnish a fair supply (400,000 gallons a day). If a larger supply were required, he regarded it as necessary to bore to the true Bunter beds below, which would be reached at something over 700 feet.

The sole progressive step taken by the Rural District Council of recent years—viz., the renting of a farmhouse for the purposes of an isolation hospital—taken under pressure from the County Council.

13. TOWCESTER RURAL DISTRICT (part of) (NORTHAMPTON): Dr. Bulstrode.

Authority concerned: Towcester Rural District Council.

Ground of Inquiry: Continued prevalence of scarlatina in the villages of Weston and Lois Weedon.

Chief Facts reported by Inspector: Cases of scarlatina not properly dealt with. This largely due to illness of Medical Officer of Health, and to incapacity of Inspector of Nuisances, a comparatively recently appointed officer without adequate knowledge of the methods by which an outbreak of this nature may be controlled. Rural District Council unprovided with isolation hospital or disinfecting apparatus; as regards certain of the invaded houses no attempt whatever made at disinfection. No proper co-operation between the local sanitary authority and the school authorities, or between sanitary authority and medical practitioners.

14*. TYLDESLEY-WITH-SHAKERLEY URBAN DISTRICT (LANCS.); population (1901), 14,843; Dr. Johnstone.

Authority concerned: Tyldesley-with-Shakerley Urban District Council.

Ground of Inquiry: Prevalence of enteric fever for some years, especially during 1901.

Chief Facts reported by Inspector: Enteric fever prevalent during the last 10 years. Death-rate from the disease in the period 1892–1901 more than double that of England and Wales. Seventy-seven cases of enteric fever notified during 1901, 12 of them fatal. That part of the town of Tyldesley, lying between Elliott Street and the London and North Western Railway line less affected by the fever than other parts. Milk, food, and water supply apparently not largely concerned with the spread of the disease. Personal infection concerned in some degree.

Privy middens large and pervious; method of removal of their contents liable to contaminate streets and back passages. Waste pipes very often defective. Paving of house yards often defective or absent. Rain-water pipes discharge directly to sewers; the latter ill-ventilated and badly flushed, besides being of insufficient calibre in parts. No disinfector provided, except that at the hospit which is only large enough for the hospital work.

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15 WEST WICKHAM PARISH in the BROMLEY RURAL DISTRICT (Kent); population (1901), 1,328; Dr. Johnstone.

Authority concerned: Bromley Rural District Council.

Ground of Inquiry: Complaints of unsanitary state of the village of West Wickham, extending over period of 12 years. Inaction of Rural District Council.

Chief Facts reported by Inspector: Owing to the geological formation, the subsoil of much of the northern part of the parish is wet. Cesspools which are universal are seldom impervious. They rapidly fill with subsoil water, and overflow in wet weather, causing nuisance. Frequent emptying of cesspools impossible, owing to the cost. No special incidence of infectious disease on the parish.

The water from several polluted shallow wells is used for drinking purposes. House yards unpaved or badly paved. System of sewerage necessary with outfall to sewage farm, or to the sewers of the Beckenham Urban District Council.

16.* WHITEHAVEN BOROUGH (CUMBERLAND); population (1901) 19,324; Dr. Reginald Farrar.

Authority concerned: Whitehaven Town Council.

Ground of Inquiry: Need for ascertaining action of the local authority in sequence to Dr. Bulstrode's inspection of the Borough.

Chief Facts reported by Inspector: Some sanitary progress since the date of Dr. Bulstrode's Report (16th July, 1902). A large number of additional water-closets provided; window sashes altered so as to facilitate ventilation; several courts re-paved.

Nothing done to remedy the chief sanitary defect in the town, viz., the gross overcrowding of houses on area. To let in light and air into the crowded courts and alleys, demolition necessary of certain houses or groups of houses; need for erection at the same time of cottages outside the present limits of the town to accommodate the population thus displaced. A housing scheme by the Urban District Council requisite.

17. WHITTLESEY RURAL DISTRICT (CAMBS.); population (1901), 3,194; Dr. Copeman.

Authority concerned: Whittlesey Rural District Council.

Ground of Inquiry: General sanitary circumstances unsatisfactory, as indicated in annual reports of Medical Officer of Health.

Chief Facts reported by Inspector: No public water supply —drinking water obtained from rain-water tanks, from rivers, from "dykes," from ditches, and from surface wells. Latter often much contaminated. Privy vaults often overfull; liquid refuse thrown on ground or into ditches. Recently increase of cottage-building in neighbourhood of brickworks, but no building (or other) byelaws in force. Structural and sanitary circumstances of older cottage property commonly unsatisfactory.

Brickworks reputed to have injurious influence on health of persons employed in them, owing, it is thought, to alternations of temperature and inhalation of carbonic oxide gas. No excessive incidence of infectious disease on the district in recent years; but infantile death-rate for 1892–1901 averaged 113·5 per 1,000. No isolation hospital. No dairy regulations in force.

18. WHITTLESEY URBAN DISTRICT (CAMBS.); population (1901), 3,909; Dr. Copeman.

Authority concerned: Whittlesey Urban District Council.

Ground of Inquiry: Reports of Medical Officer of Health. Local complaints.

Chief Facts reported by Inspector: No public water service. Water of public pumps described by analyst as "polluted with sewage." Public supply might be obtained at comparatively small cost by extension of main from Peterborough; in view of geological conditions, little likelihood of obtaining, locally, one of satisfactory nature.

Street sewers, which beside slop refuse receive overflows from cesspools and privy vaults, fitted with catchpits at intervals of 100–500 yards. Sewers have so little "fall" that contents often stagnate. Crude sewage discharged to River Ouse.

Slaughter-houses are registered, but practically they are not supervised. No regulations under Dairies, Cowsheds, and Milkshops Order, 1885. Much complaint of nuisance from keeping of pigs.

Incidence of infectious disease not excessive; but in 1897–1902 general death-rate averaged 17·78, and infantile

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death-rate 132·2. Amount of rate for sanitary purposes limited to 3*s.* 6*d.* by Local Act.

No isolation hospital. Building byelaws in existence but not enforced.

19. WREXHAM RURAL DISTRICT (DENBIGHSHIRE); population (1901), 55,188; Dr. Darra Mair.

Authority concerned: Wrexham Rural District Council.

Ground of Inquiry: Sanitary administration; two Medical Officers of Health; question of the adequacy of inspection of nuisances.

Chief Facts reported by Inspector: Rural District Council though in a position, by the decease of one Medical Officer of Health to appoint one officer for the whole district, declined to do so. District one of the most populous rural districts in England and Wales; large part of it, where coal mining is the chief industry, consisting of several densely populated towns. Both Medical Officers of Health in active medical practice, doing but little systematic sanitary work. Sanitary Surveyor also in active private practice, deputes most of his building inspection and supervision of drainage systems to a private assistant. Only two Inspectors of Nuisances, one serving population of 30,500; the other, one of 25,000. District possesses good isolation hospital, but no separate building for smallpox. Hospital adjoins site of the Union Workhouse.

Populous parts of district supplied with constant public service of water; several drainage systems, but large and populous areas still not drained. Most of the district served by midden privy system. District Council take no action at all to scavenge midden privies. Occupiers are held to be entirely responsible; result, contents of privies and ashpits are cast anywhere and everywhere, even in most densely populated parts.

Many nuisances observed; dwelling houses in need of sanitary inspection. Some back to back houses have been recently built, although modern building byelaws are in force; these byelaws and enactments regarding new dwellings found to be infringed in other respects.

Appointment of one Medical Officer of Health, and of one or two additional Inspectors of Nuisances recommended; also cleansing of privies and ashpits by the District Council, the provision of other drainage systems and the provision of separate smallpox hospital.

No 4.

THE PUBLIC HEALTH ACT, 1875,

AND

THE BEDFORD CORPORATION WATER ACT, 1902.

REPORT on an INQUIRY held by Mr. H. R. HOOPER and Dr. G. S. BUCHANAN on the 16th, 19th, and 22nd February, 1904, with reference to an APPLICATION of the TOWN COUNCIL of the BOROUGH OF BEDFORD for sanction to borrow £24,000 for purposes of their WATER UNDERTAKING.

WHITEHALL, S.W.

18th March, 1904.

SIR,

WE have the honour to report that we held this Inquiry at the Town Hall, Bedford, on the 16th, 19th, and 22nd February, 1904.

There were present :—

On behalf of the Bedford Corporation :—Mr. C. Stimson, Barrister. *Witnesses* :—Major Tulloch, C.B., R.E., the engineer of the proposed scheme ; Sir William Crookes, F.R.S. ; Professor Dewar, F.R.S. ; Mr. Candy, representing the International Water Purification Co. ; Dr. Angell ; Mr. Lund, Local Consulting Engineer ; Mr. G. L. Eastes, M.B., B.Sc. ; Dr. Prior, Medical Officer of Health ; Mr. Councillor C. Wells ; Mr. Greenshields, Borough Surveyor ; Mr. P. Edwards, Engineer at Pumping Station.

For the Opposition :—Mr. Councillor Halliley, Solicitor. *Witnesses* :—Professor Boyd Dawkins, F.R.S. ; Dr. Klein, F.R.S. ; Dr. T. Stevenson, F.R.C.P. ; Mr. G. F. Deacon, M.I.C.E.

Others present :—The Mayor of Bedford and many of the Town Council ; Mr. W. W. Marks, representing Bedford County Council ; Mr. W. Sharman, representing Bedford Rural District Council ; numerous ratepayers and representatives of the Press.

APP. A, NO. 4.

Bedford Water Supply; by Mr. Hooper and Dr. Buchanan

The Application is made in pursuance of two resolutions of the Town Council on 15th July, 1903, and 20th October, 1903, applying to the Board for sanction to loan of £20,000 and £4,000 respectively.

General Statistics as regards Bedford.

The Clerk gave us the following :—

Area of Borough	2,200 acres.
Population, 1891	28,023
„ 1901	35,526
„ estimated at present ...	37,100
Annual Assessable Value	£157,358
„ „ (after 31st March next) ...	£195,000
Outstanding Loans	£118,846
Rates: General District, 2*s.* 10*d.* / Poor Rate, 4*s.* 6*d.* ...	7*s.* 4*d.* per annum.
1*d.* in the £1 produces	£583
Amount of Loan now applied for ...	£24,000
Period for repayment asked for ...	Longest possible.

History of the application.

The present Bedford Waterworks were constructed under Provisional Order in 1868, commencing with a well 25 feet deep, sunk into the Great Oolite by the side of the Ouse above Bedford. For this a loan of £20,000 was sanctioned, now all paid off.

1871.—The first heading, 174 feet long, was driven.

1875.—The heading increased by 191 feet.

1883.—Mr. Mansergh was called in to advise upon an increased supply. He recommended the extension of the headings, but as an experiment without any hope of the results being adequate or sufficient for future requirements.

The following points in this Report may here be noted :—

i. The basis of supply was taken as 27⅔rds gallons per head.

ii. The increase of supply from an extension of the headings must necessarily be a matter of the vaguest conjecture.

iii. There can be no great underground reservoir of water, for the beds of rock are too thin.

iv. The area of the gathering grounds is uncertain.

v. The water from the River Ouse (although averaging 125 million gallons per day past the Pumping Station, with a minimum of 40 million gallons in dry seasons) was not recommended as an addition to the supply owing to dangers of pollution from the untreated sewage of some 14 small towns and villages in the upper reaches, which must, in part at least, find its way ultimately to the river.

vi. The Lower Greensand, several miles to the south of Bedford, would produce a water of great purity, but the cost of such a scheme would be very great.

1884-5.—The heading was extended 446 feet. Loan for £9,000 sanctioned for waterworks purposes, £3,600 of which is now outstanding.

1895.—Branch heading, 463 feet long, driven.

1899.—Portion of the headings deepened.

1901.—Mr. Deacon called in to advise. He reported that existing filters were insufficient, and under his advice two additional temporary circular filters were constructed. He proposed, however, that Bedford should turn to an entirely new source for water, viz., to the Greensand. This scheme was unanimously adopted by the Town Council, and an Act of Parliament was obtained in July, 1902, authorising the borrowing of sums not exceeding £135,000 for carrying out the same. (Bedford Corporation Water Act, 1902, Section 46.)

Soon after a reaction set in. An important section of the Town Council opposed the Greensand scheme, on the ground of its cost, and advocated further improvements on the present supply. This section has been reinforced at various municipal elections stated to have been fought on the "water question,"* and the opponents of the Greensand are now in a considerable majority on the Town Council.

1902.—In December Major H. Tulloch was called in to report on the possibilities of the present source of supply; and in June, 1903, he submitted a printed Report advocating the continued use of the existing works, with various additions and improvements.

This Report was adopted by the Town Council, and as a result application is now made to the Board for a loan of £24,000 in respect of which this Inquiry was held.

The works proposed are as follows:—

1. Stoppage of waste.
2. Driving a further heading.
3. Increasing filtration—
   - (*a*) By an installation of eight "pressure filters."
   - (*b*) By the construction of two circular "aerobic"† filters.
   - (*c*) by alterations in the existing filters to enable them to act "aerobically."

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* We gathered that the "Greensand" and "Rock" parties are strongly opposed on other matters besides water.

† It is convenient to use Major Tulloch's term "aerobic" in reference to these filters, but we would not be understood to be denying that ordinary sand filters act aerobically.

4. Improvement in existing reservoirs by the use of floating arms, &c.

5. Purchase of the right to quarry on land belonging to Mr. Franklin which adjoins the headings.

6. Laying a second main from the service reservoir to the town.

The general contention of the Corporation in supporting this scheme is that a sufficient supply will be obtained, and efficient safeguards provided for the purity of the water, at a cost considerably less than the Greensand scheme. These points were contested by the opposition, represented by Mr. Halliley on behalf of a minority of members of the Town Council, who strongly object to the abandonment of the Greensand scheme.

The Inquiry lasted three days and excited considerable local interest. On February 17th, 18th, and 23rd we visited the existing works and the land in their neighbourhood, including Mr. Franklin's quarries. We also visited the general surrounding country, including the villages of Clapham and Milton Ernest on the east bank of the river, and the district to the north of Kempston on the west bank. At Kempston we had under consideration a proposal to supply the Kempston Urban District with water from a well in the Oolite.

Scheme of Report.

We have divided this Report into parts as follows :—

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PART I.

PRESENT CONDITION OF UNDERTAKING.

WORKS.

The Pumping Station is situated on the east bank of the River Ouse, north-west of the town, and contains the following plant:—

One 40 h.p. Plunger Pump, 19 strokes per minute at 30 gallons per stroke, equals per 24 hours...	820,800	gallons.
One 50 h.p. Plunger Pump, 19 strokes minute at 40 gallons per stroke, per equals	994,400	„
Total capacity...	1,815,200	„
Deduct 10 per cent. for slip...	181,520	„
Total effective capacity ...	1,633,680	„

The pumps are driven from two low-pressure Lancashire boilers at 45 lbs. per square inch.

The reservoirs and filters are on the top of an adjoining hill, the lift from the receiving well to the settling reservoir is 164 feet.

The Rising Mains are 15 inches and 12 inches diameter respectively.

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*Settling Reservoir** 224 feet by 120 feet by 8 feet, equals 1,256,000 gallons; as water, however, cannot be drawn off within 4 feet of the bottom, the effective quantity is only *628,000 gallons.*

Filters.

Two Rectangular,	76 feet by 43 feet,	equals	726 square yards.
One „	79 feet by 43 feet,	„	377 „
Two Circular (temporary)	72 feet, diameter,	„	906 „
Total			2,009 square yards.

Assuming the supply to be 1,000,000 gallons per day, the filters must work at 500 gallons per square yard or 4·48 inches per hour without making any allowance for cleaning, repairs, &c.

Service Reservoirs.—Two 60 feet by 60 feet by 16 feet deep equals 718,000 gallons. The working depth only averages 13 feet 6 inches, and the minimum depth for supply is 5 feet 6 inches. The available 8 feet of depth represents 360,000 gallons, which is practically 36 per cent. of one day's supply.

SUPPLY.

This is derived mainly from the headings which comprise one length of main heading 810 feet long, and one branch heading 462 feet long. As will be shown in Part II. below, the supply has on occasion been supplemented, to an altogether uncertain extent, by water taken directly from the Ouse, while there is also evidence that Ouse water leaks into the pump well.

The estimated consumption during the three years preceding 1902 is given at 26 gallons a head. This, taken on the present population of 37,100, is approximately 1,000,000 gallons a day. Owing to the use of Ouse water in dry seasons there has been no very conspicuous shortage of water in Bedford in recent years, although in dry seasons notices have been issued to prevent the use of water on gardens, while for street purposes it has been taken direct from the river.

PART II.

SOURCE AND AMOUNT OF PRESENT SUPPLY, AND THE PROPOSALS FOR ITS INCREASE.

The geological map in Major Tulloch's Report shows the course of the Ouse for over 20 miles above the Pumping Station. A copy of this map is here inserted. The river is tortuous, and traverses

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* Referred to at Inquiry and in Major Tulloch's Report as the "*storage* reservoir."

a flat plain of variable width, liable to considerable flooding. As stated above, its minimum flow at the waterworks in dry weather is given at 40 million gallons a day. The country on either side of the river plain consists generally of low, flat-topped hills which, in many places, have a sharp slope down to the river plain.

Throughout this course the river flows upon the Great Oolite, which is usually covered by alluvium. The Great Oolite, which in the neighbourhood of Bedford, is said to be from some 16 to 30 feet in thickness, underlies the whole of the area shown in the map, at about the river level. It consists of limestone, fissured and jointed at frequent intervals; the direction of the main joints being (according to Professor Dawkins) from N.N.W. to S.S.E., and at right angles thereto. Here and there it contains thin bands of clay, which sometimes throws out springs.* The Great Oolite rests on beds which are practically impervious ("estuarine" and lias series).

Above the river plain the Great Oolite is covered successively by "Great Oolite Clay," usually abont 10 feet thick, and by Cornbrash (thin bands of limestone, locally called "Pendle," usually two to three feet thick and sometimes absent). Great Oolite Clay and Cornbrash appear to be represented together in the red colour ("Cornbrash") of the map.

On both sides of the Ouse from Sharnbrook to Bedford (all the eastern half of the map) impervious Oxford clay overlies the Cornbrash.

The dip of the strata is from N.W. to S.E., but is comparatively slight. Broadly speaking, the Great Oolite, "Cornbrash," and Oxford Clay come to the surface only on the slopes or at the foot of the hills. The flat tops of the hills are mostly covered with a considerable thickness (up to 100 feet) of boulder clay. Here and there are areas of gravel at a considerable height above the river, usually resting on clay (Oxford or boulder clay).

The main heading of the Bedford Waterworks is 270 yards long, and its direction is from west to east, at right angles to the river. The Great Oolite is here some 16 to 18 feet. According to Major Tulloch's data, the floor of the heading is practically horizontal, its height varies from 9 to 16 feet, and its width is from three to four feet, or more in places. At the western end (pump well), the heading goes down to the base of the Great Oolite; at the eastern end, owing to the dip, the heading taps only the upper eight feet of the Great Oolite.

The branch heading to the south-east passes through practically the whole thickness of the Great Oolite for some 130 yards. At its termination there is a slight fault, beyond which the top of the Great Oolite is very little above the floor of the heading. A plan of the headings, with sections showing various O.D. levels, is given in Major Tulloch's report.

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* *Cf.* Major Tulloch's Report, page 5. We saw a good spring of this kind by the side of the Ouse at Milton Ernest.

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The quantity of water obtained from these headings in years past is unfortunately a matter of mere conjecture. Major Tulloch gives the following table in his report :—

Year.	Yield in Gallons per week.		Headings.
1871	1,491,250		Heading driven 174 feet in 1870.
1875	2,463,360		„ extended 191 feet in 1874.
1886	*4,198,644	Average of 12 months' pumping.	„ „ 446 feet in 1884–5.
1898	*6,330,724		„ „ to south-east, 463 feet, in 1897 (branch heading).
1900	*6,702,990		„ deepened in 1899.
1903	7,000,000		

* Some proportion of this quantity is river water. The above figures are taken from the pumping returns.

It is admitted that since the last addition to the headings (deepening in 1899) they have failed to yield sufficient water in periods of drought, and that the deficit has been made up by the admission of river water. Mr. Edwards (foreman at the water-works since 1875) estimated that the largest quantity of river water admitted in any one week was 1½ million gallons (*i.e.*, over 200,000 gallons per day), and said that the river water had only been admitted for a few weeks in any year. As, however, no proper observations or records have been made or kept these statements must be taken with due caution. Admission of Ouse water was facilitated after 1901, when Mr. Deacon caused an 8-inch pipe to be laid for the purpose; but in previous years river water was admitted to the pump well, whenever required, through the 3-inch pipe laid for the condensers.

It was stated by Mr. Edwards, however, that during last year (1903) no river water was purposely taken,* and that throughout the whole of that year the headings yielded all that was necessary (1,000,000 gallons a day). We have no reason to doubt this statement, which was not contested by the opposition. But it only affords an indication of the quantity obtained from the headings in an exceptionally wet year, and even in this case some allowance must be made for direct leakage of river water into the pump well. On our inspection we saw a considerable quantity of river water pouring into the well from leaks in the brick wall. We were told by Mr. Deacon (for the opposition) that these leaks had been considerably greater in the past than they are at present.

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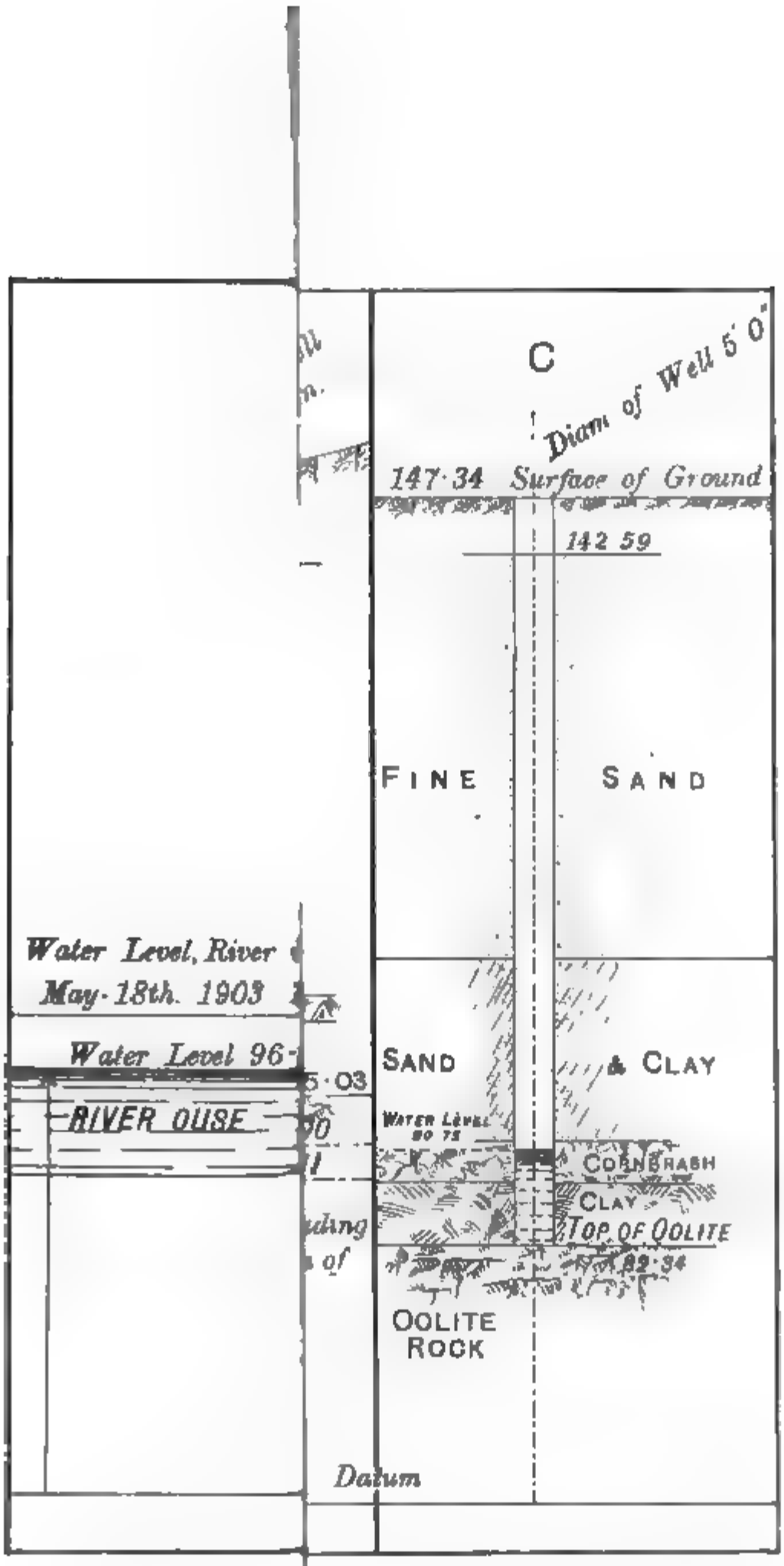
* In the latter part of 1902 the Town Council ordered that no river water should in future be taken.



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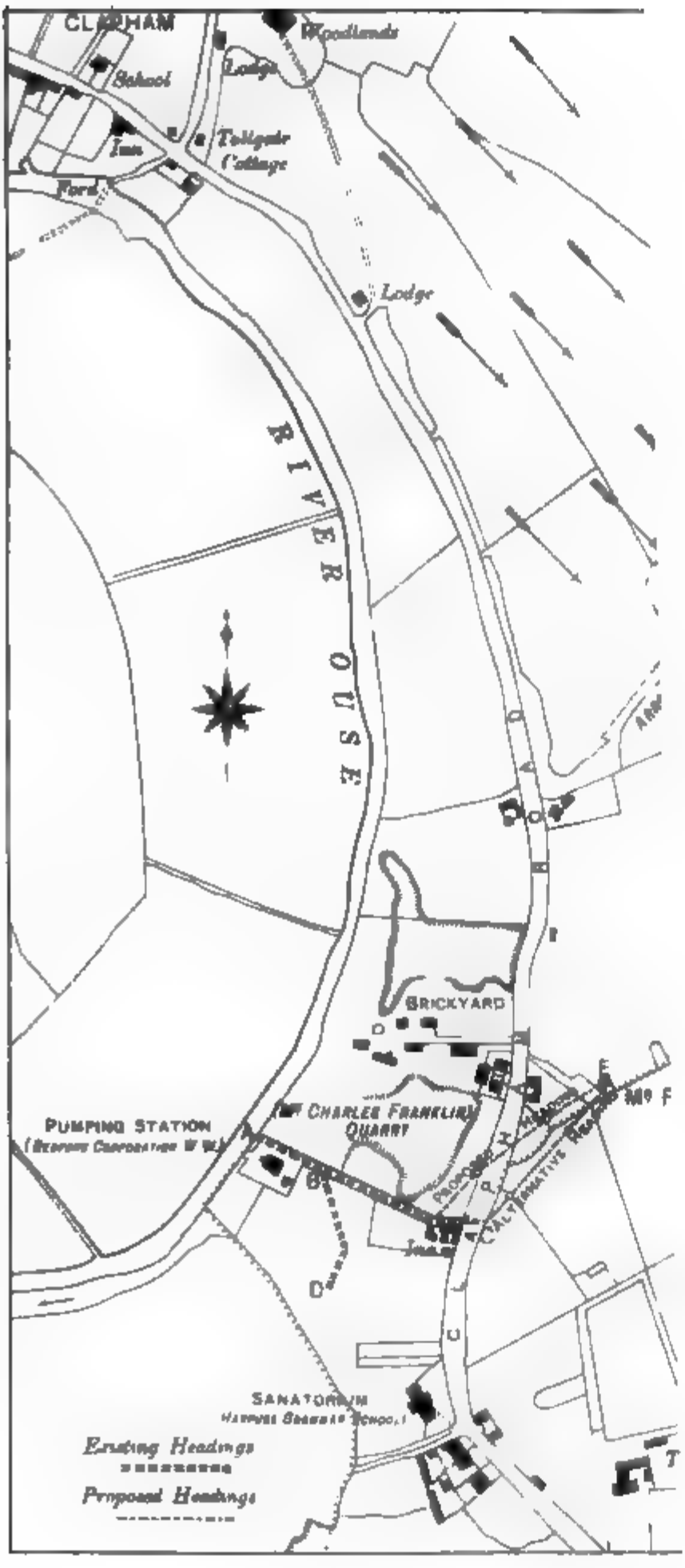
CLAPHAM
Woodlands
School
Lodge
Inn
Tollgate Cottage
Ford
Lodge
RIVER OUSE
BRICKYARD
PUMPING STATION
CHARLES FRANKLIN QUARRY
SANATORIUM
Existing Headings
Proposed Headings

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Evidence was given by Mr. Lund (former Borough Surveyor), who superintended the sinking of Franklin's well in 1901. The well was pumped continuously for about a week without appreciable effect upon the level. The pump, however, was small, and the quantity taken was not more than 70,000 to 80,000 gallons a day.

On April 24th, 1903, water was pumped out of the waterworks headings in order that they might be inspected. The level of the water in the pump well fell some four feet. Franklin's well was only slightly affected by this proceeding, the fall being less than six inches. (Major Tulloch's report, p. 8.)

In support of the view that the water in Franklin's well is not held up merely by local disturbance of strata,* but is part of a large body of water in the Oolite at this level, Major Tulloch gives observations as to two wells to the south-east and east of Franklin's well, Mr. C. Wells' well, and the Park well. In each instance the rest level of the water is about the same as that in Franklin's well. At the Park well the Oolite is deeper than at Franklin's well, and the water level is some 15 feet above the top of the rock.

Mr. C. Wells gave evidence as to the first of these wells. It yields sufficient water for the requirements of his brewery—14,000 to 18,000 gallons a day—but has never been subjected to continuous test pumping. The well in the Park was intended to supply an artificial lake, but it has not been necessary to draw on it.

As further evidence of the additional supply likely to be obtained by extending the headings in an easterly direction, Major Tulloch points out that the greater part of the water obtained from the existing main heading comes in at the eastern end. He considers that at this end the heading taps a considerable volume of underground water flowing from north-west to south-east.

In connection with the question of pollution (Part IV. below), the Opposition laid great stress on the circumstance that when the heading was extended in 1884-5 the wells into the Great Oolite at Clapham (¾-1 mile to the north) were affected, and in some cases had to be deepened. Evidence to this effect was given by Mr. Fitzpatrick, Chairman of the Clapham Parish Council, and we obtained confirmation of it on our visit to Clapham. This circumstance tends to confirm the view that the bulk of the water obtained from the main heading is drawn from the north and north-west.

The opponents of the scheme argued that the river had little or no influence on the water in the Great Oolite, that this formation obtains its water almost entirely from direct rainfall on the limited area where its surface is exposed, or from drainage flowing from the impervious strata above, and that consequently no practicable extension of headings would be likely to yield sufficient water in time of drought. This thesis was maintained both by Professor Boyd Dawkins and by Mr. Deacon.

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* We saw evidence of small local disturbances in the Great Oolite in two or three places; notably at a gravel pit west of Clapham.

Professor Dawkins pointed to a large area, coloured "Great Oolite" on the one-inch geological map, north of Sharnbrook, which he thought was the main source of the water in the Great Oolite near Bedford. He did not dispute that much of this yellow area is sealed by boulder clay and drift just as is the case in the area shown on Major Tulloch's geological map, but he stated that a great deal of the water falling on this drift would ultimately reach the Oolite. River water might enter at certain places. But geologists now attach increased importance to the comparative imperviousness of the silt of a river bed, and he was inclined to think that the water of the Ouse, even in the higher reaches, had little to do with the water in the Great Oolite near the waterworks. He was familiar with the Great Oolite in parts of Northamptonshire, but had not made any detailed study of the local conditions near Bedford; he had given a day to investigating the locality at the request of the Opposition.

Mr. G. F. Deacon, M.I.C.E., went further than Professor Dawkins on this geological question, and while admitting that spring water might come up from the Great Oolite into the bottom of the Ouse, said that the river deposit would prevent a reverse current from Ouse to Ooolite. He was aware, however, that such a reverse action had been shown in the case of the chalk in the Lower Thames.

Two analyses of Ouse water near the pumping station were supplied at the Inquiry, (*a*) by Sir William Crookes, of a sample taken on February 4th, 1904, when the river was in flood, and (*b*) by Dr. Stevenson, of a sample sent to him by the Kempston Urban District Council in November, 1902.

Per 100,000 (*a*) gave 26·14 and (*b*) 37·6 parts of total solids, whereas a sample of water from the headings taken for Sir William Crookes at the same time as (*a*) showed as much as 55·14 parts of total solids per 100,000, and a number of other analyses shows that the usual proportion of total solids in water as delivered in Bedford is somewhere between 41 and 50 per 100,000. Similarly, the hardness of Bedford water is considerably greater than that of either of the two samples of Ouse water (*cf.* analyses appended below). These data, so far as they go, tend to show that the water obtained from the headings differs materially from the river water near the pumping station. Dr. Stevenson in reply to us said that he thought the difference in total solids and hardness too great to be accounted for by a supposition that the Oolite water was mainly Ouse water which had traversed several miles of fissures.

In connection with the question of local pollution (Part IV. below), Mr. Deacon exhibited a large chart showing the level of water in the pump well day by day from April to July, 1903, and also the daily amount pumped and the daily rainfall. Unfortunately the daily level of the Ouse had not been recorded. This chart indicated that (the amount of water pumped daily being fairly constant throughout the period) any marked rainfall was followed by a rise in the level of the water in the headings in the course of a few (three to five) days, while the level dropped again

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comparatively rapidly with dry weather. This seems to us more likely to correspond with fluctuations in the level of the river than with variations in the level of underground water caused merely by percolation independent of the Ouse.

Summary as to Water available by the Proposed Extension of Headings.

It seems certain that the greater part of the water now pumped enters the main heading at its eastern end, and the facts as to Franklin's well show that an additional supply may reasonably be anticipated if this heading is extended in a north-easterly direction, as proposed, as far as that well.

How far the proposed extension would supply sufficient additional water in dry seasons depends largely on the question whether the Oolite is fed to a considerable extent by river water in the upper reaches to the north and north-west. The data supplied, taken as a whole, suggest that this is probable, but they are very incomplete. The evidence is especially faulty as regards comparative water levels. We could obtain no information as to fluctuations in level of the water in Franklin's well, or in the wells in Bedford or elsewhere, in relation to the level of the Ouse.*

A series of observations of this kind, made under geological advice, and extended over a considerable period, would have been most valuable. In the absence of such data, we think it necessary that the proposal for increasing the supply should be received with caution. It is safest to regard it as liable to fail in dry seasons to provide sufficient water, with the result that the supply may have either to be supplemented in the future, as in the past, by direct admission of Ouse water to the pump well, or else further headings, possibly away from the existing works altogether, would have to be constructed.

As regards abstraction of Ouse water, Mr. Halliley, for the Opposition, stated that certain millowners had objected to the Corporation taking water from the Ouse, and had threatened to apply for an injunction. The Town Clerk undertook to inquire into the matter, and has since written to inform us that only two small mills could claim to be in any way affected.

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* The only observation on this point was a statement by Mr. C. Wells that on one occasion the water in his well had dropped several feet at a time when the Ouse had been in flood and was rapidly falling. Major Tulloch shows that the Park well was affected by a rise in the river in May, 1903.

PART III.

WASTE—PAST, PRESENT—AND SAVING TO BE EFFECTED.

Major Tulloch, on page 26 of his Report, states his opinion that 200,000 gallons per day, or even 300,000 or 400,000 gallons, can be saved by a proper prevention of waste. The Borough Surveyor, who probably knows the local conditions more intimately, states that 70,000 to 100,000 is the maximum that could be saved, as effective measures during the last 18 months have already saved 96,000 gallons per day.

We are therefore of opinion that some 70,000 gallons per day is all that can be regarded as likely to be saved, and would recommend that the Board sanction a loan for this purpose.

Major Tulloch simply includes £1,000 for this item, but we consider that some details of the proposed expenditure should first be submitted to the Board.

PART IV.

QUALITY OF THE PRESENT SUPPLY.

(1.) Opportunities of Pollution of Water reaching the Headings.

Evidence as to risk of pollution of the water in the headings was given by Mr. Deacon, Professor Boyd Dawkins, and others, and in course of our inspection we looked at the various places indicated by these witnesses.

In the neighbourhood of the waterworks the Great Oolite was stated to be liable to dangerous contamination (*a*) along the edge of the river, and (*b*) in certain lands excavated for brick making, (*c*) at the village of Clapham.

(*a*) *Edge of River.*—The risk in the first case seems relatively small. Almost immediately above the river level the Great Oolite is covered by Great Oolite clay, and a little higher up the slope Oxford clay is also reached. The area in which, according to the geological map, the Great Oolite comes to the surface is restricted to a narrow strip bordering the river bank, from a point about a quarter of a mile above the pumping station to about one mile below it. The greater part of this strip is to the south and west of the headings, *i.e.*, opposite to that from which the headings appear principally to draw. The strip in question is covered by surface soil, no doubt consisting partly of river deposit and partly of clay washed from the banks above. We saw no evidence of bare rock along this strip, and it should be noted that it is covered to a large extent by good-sized trees and by undergrowth. Various

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small ditches discharge into the river across the strip. At the date of our visit the water in these ditches seemed to be running straight into the river without soaking into the soil; it is quite likely, however, that after drought, when the surface soil over the Oolite is cracked, a portion of the drainage from the upper lands would soak through to the Great Oolite instead of reaching the river.

The drainage in question is mainly derived from agricultural land, and to some extent from the quarries referred to below. As regards the dwellings on the Clapham Road (roughly parallel to the river on a higher level), there are eight cottages by the side of this road on the north of the headings (all in the Bedford Rural District). These cottages have pail privies or pit privies; some have cesspools, while in others slop water is thrown on to garden ground or reaches the road ditch. Some of the slop water, and also cesspool overflows, is thus carried down to the river, crossing the narrow strip of "Oolite" above mentioned. For about 600 yards to the south of the headings there are about a dozen dwellings on either side of Clapham Road. These dwellings are in the borough, and with one exception are now being connected to a sewer. At present they have pail closets and cemented cesspools, which are emptied at frequent intervals by the Corporation officials. One of these dwellings is the Harpur Grammar School Sanatorium, which is used for isolation of cases of infectious disease. It is a temporary structure with two ward blocks, and we were informed that as many as 16 patients could be accommodated there. In this case the cesspool is cemented and said to be emptied three times a week by the Corporation officials. The cesspool has an overflow to a neighbouring ditch leading to the river at a point about 100 yards below the pumping station. This ditch also receives a three-inch iron drain from the house of the foreman at the pumping station and the overflow from a cesspool at the "Angler's Rest" in the Clapham Road. It is not proposed at present to carry the Clapham Road sewer as far as the "Angler's Rest."

All these dwellings in the Clapham Road stand well above the river level (30-40 feet), and they are separated from the Great Oolite by a considerable thickness of clay. The Clapham Road sewer now being laid is of cast iron at considerable depth below the roadway. The Ordnance level of the invert at the end by the Sanatorium is 124·65, and at the junction with the existing sewer in Shakespeare Road 122·09. The top of the Great Oolite at the pumping station is about 94 + O.D. The Surveyor stated that the trench for this sewer is in clay to the bottom, and that he believed that this clay was entirely above the "Cornbrash" and Great Oolite clay.

(*b*) *The excavated lands* in question are (1) those in Franklin's field, which begin a few yards north of the main heading, and (2) those in the Fairfield brick and tile works, about 600 yards to the south.

In Franklin's field (about 15 acres) a large part of the upper strata has been removed for brick making, and in places the land has been excavated through Cornbrash and Great Oolite clay down

to the Great Oolite. The latter has been got out mainly in order to obtain lime. As a result there are several areas in this field in which the great Oolite is freely exposed.

At the foot of these excavations, at the dates of our visits, there were pools of water, the level of which no doubt corresponded with the level of the water in the headings. We had evidence of the free communication between these pools and the headings on the afternoon of February 18th. There had been a sharp frost the night before, and ice had formed in the pools. The day's pumping had reduced the level, as indicated by the position of the ice, in one instance (pool nearest the heading) as much as 18 inches; in two other pools, farther away, the fall had been about three and eight inches respectively.

The dangers of these areas of exposed Oolite is obviously great. Some 40 men are employed in brickmaking, &c., in Franklin's field in busy times. A single pail privy is provided for them down by the river, but it is certain that there is considerable risk of direct excremental pollution in the hollows where the Oolite is exposed; moreover, washings from the surface of various parts of this field are sure to find their way to the Oolite, and so to the headings.

In the Fairfield brickworks the excavations show nothing but clay, and it is probable that they have not got as low as the Cornbrash. Water is held up by the clay in the excavated area, and a drain has lately been made to carry this water to the river some distance below the pumping station. At the present time, therefore, there seems no evidence that the Fairfield brickworks occasion risk to the water supply.

So far as we could ascertain, there is no proposal to use other fields on either side of the river for brickmaking.

(*c*) It was stated by Mr. G. F. Deacon, Professor Boyd Dawkins, and Dr. T. Stevenson, that there is risk of contamination of the water drawn into the headings by reason of pollutions of the Great Oolite in the village of Clapham (population about 700) from three quarters to one mile to the north. At Clapham the Great Oolite is covered by alluvium. The wells go down to the Oolite, and, as stated in Part II., they have been affected by extensions of the headings. There are numerous uncemented cesspools in Clapham, and it was stated that these also go down through the alluvium into the Oolite. Our local inquiries, however, indicated that this is probably not often the case. The contents of Clapham cesspools do not appear to soak away very readily; they are said frequently to give trouble by overflowing. Nevertheless, there is considerable probability that the contents of these cesspools may soak through into the Oolite and so mingle with water which is being drawn towards the headings.

No suggestion was made at the Inquiry of risk of pollution of the Oolite further to the north than Clapham. We visited the next village, however, Milton Ernest, about three miles north of the waterworks. This village differs altogether from Clapham in that there is no alluvial covering of the Great Oolite by the side of

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the river, and the village is traversed by watercourses fed by springs issuing from the Oolite. The slop water from most of the dwellings drains directly into these watercourses.

2. Pollution of the Ouse.

The present proposal does not contemplate that Ouse water will be taken direct, and we did not therefore investigate in any detail the sources of contamination of the Ouse above the pumping station. The river, which is frequently in flood, receives in its windings the drainage of large areas of agricultural land. The following data were given for the Corporation as to villages by the side of the Ouse for 22 miles above the pumping station :—

Village.	Distant by River.	Approximate population.
	Miles.	
Clapham	1	750
Stevington	4	400
Pavenham	5	500
Milton Ernest	8	750
Bletsoe	11½	300
Sharnbrook	13	500
Felmersham	14½	300
Odell	16	250
Harrold	17	750
Chellington	17	300
Turvey	20½	500
Cold Brayfield	nearly 22	250
	Total population (22 miles)	5,500

All these villages except the last are in Bedford Rural District. We have referred above to the drainage of the two villages visited—Milton Ernest and Clapham. It was pointed out by the Opposition that the total population on the watershed area of the Ouse above Bedford, and within 20 miles by *direct measurement* from the town was considerable. On this reckoning some 57 parishes in Buckinghamshire (including Olney, population 2,684, and Fenny Stratford, population 3,571) and 11 parishes in Northamptonshire would be included, and it was stated that the total population on the watershed within 20 miles was 52,000, on an area of 480 square miles.

3. Present System of Filtration.

The dimensions of the three rectangular sand filters and of the two "temporary" filters have been given on page 40. The downward rate of percolation, if all the filters were in use and working uniformly, comes out at 4·48 inches per hour (or 500 gallons per square yard) on a supply of 1,000,000 gallons a day. But it is admitted that the effective area of filtration is much reduced by the position of the inlet and outlet pipes of the filters, and by other structural defects which Major Tulloch deals with in detail in his report. The foreman at the filter works informed us that the surface of the filters generally has to be renewed in from eight to thirteen weeks.

4. Chemical and Bacteriological Evidence as to Present Supply.

A series of chemical analyses by the Borough Analyst, Mr. J. R. Colwell, was produced by the Corporation. These relate to 12 samples of water taken in the town; 14 of water as it leaves the filter beds or from the service reservoir; and five of unfiltered water. These samples were taken at different dates between May, 1902, and November, 1903. A summary of these analyses will be found below (Addendum I.) The 26 samples of town water and filtered water show the following range:—

	Parts per 100,000.	
	Maximum.	Minimum.
Chlorine	3·0	2·3
Nitrogen as nitrates	0·056	0·005
Albuminoid ammonia	0·015	0·007
Oxygen absorbed in one hour	0·330	0·209
Total solids	56·1	41·0
Total hardness	38·0	29·0

The worst of the above samples (as regards oxygen absorbed and total solids) was taken from the outlet of the filter beds on 24th March, 1903. There had been heavy rainfall on the previous day.

. A, No. 4. nd Water ly; by Cooper Dr. mson.

Of the five unfiltered samples, three were taken from the pump well or from the settling reservoir :—

	Parts per 100,000.		
	Pump well.	Pump well.	Settling reservoir.
	June 19th, 1902.	13th May, 1903.	13th May, 1903.
Chlorine	2·92	2·2	2·2
Nitrogen as nitrates ...	0·0127	0·032	0·035
Albuminoid ammonia ...	0·013	0·014	0·013
Oxygen absorbed 1 hour...	0·269	0·328	0·354
Total solids	49·0	58·0	51·8
Total hardness	40·0	32·5	33·5

Other two samples were taken on May 13th, 1903, from the main and branch headings respectively. The branch heading sample showed larger amounts of total solids and of chlorine, and less oxygen absorbed and albuminoid ammonia. No samples of Ouse water had been examined by Mr. Colwell. Sir W. Crookes supplied a report (Addendum II.) of analyses of five samples collected on 4th February, 1904, one of which was Ouse water, and Dr. Stevenson supplied an analysis of Ouse water taken in 1902 below the waterworks (Addendum III.) No systematic analyses of Bedford water appear to have been made before 1902, and the Town Clerk informs us that he is unable to find records of past analyses save on one occasion, in April, 1898.

A series of bacterial analyses made for the Corporation by Dr. G. L. Eastes (or by Mr. Jolliman, at his laboratory) was also put in, and Dr. Eastes gave evidence with regard to them. These were samples taken for Dr. Eastes by an assistant on various dates between July, 1902, and November, 1903. The samples taken were 60 cc. in most instances. They were tested for total number of bacteria and for presence of B. coli (Pakes' method). In June, 1903, certain duplicate samples were sent by the Corporation to Professor Dewar and to Dr. J. Thresh. A summary of these various analyses will be found below.*

On two occasions in May, 1903, after a period of heavy rain, samples were taken from different points in the headings. B. coli was found by Dr. Eastes in 5 cc. of water from the main heading on May 8th, and in 1 cc. of water from the pump well on May 13th. It appears to us, however, that the observations made are too few, and the particulars which we obtained as to the

* Not here reproduced.

collection of these samples are too vague, to enable any valid conclusion to be drawn from the results.

APP. A, No. 1. Bedford Water Supply; by Mr. Hooper and Dr. Buchanan.

At different dates five samples of unfiltered water from the settling reservoir was tested by Dr. Eastes; B. coli was found in 1 cc. on May 13th, and in 10 cc. on May 30th, 1903. In the remaining instances B. coli was absent from 40 or from 60 cc.

A total of 29 samples of filtered water, taken from the service reservoir, filter beds, and taps in the town, were examined by Dr. Eastes, during the period mentioned. With three exceptions B. coli was reported absent from, or not present in less than, 45 or 60 cc. The exceptions were 14th November, 1902, when a sample of town water contained B. coli in 5 cc., the total number of bacteria being only 94 per cc.; 22nd May, 1903, a sample from the outlet of the filter beds, B. coli in not less than 15 cc., total bacteria 362; and 30th May, 1903, a sample from the service reservoir, B. coli in not less than 20 cc., total bacteria 28.

Dr. Eastes supplies one analysis of Ouse water, by the pumping station (December 1st, 1902). This contained B. coli in 1 cc. and 800 bacteria per cc.

Sir William Crookes furnished an analysis of Ouse water (in flood) taken on February 4th, 1904 (Addendum II.)—B. coli present in 30 cc., total bacteria 9,160 per cc. On the same day no B. coli was found in samples from the heading, service reservoir, or town main. These samples showed 558, 35, and 36 total bacteria per cc. respectively.

5. Contentions as to Quality of the Present Supply.

Upon the various data referred to above, the Corporation contended, with the support of Major Tulloch, Sir William Crookes, Professor Dewar, and Dr. Eastes, that the present source of supply is one which in general has been satisfactory, and that if measures are taken to exclude surface water in Franklin's field (*see* their proposal below) and a thorough system of filtration is adopted, the quality of the water supplied to Bedford will be above suspicion. Sir William Crookes and Professor Dewar in support of this thesis pointed out that the water is initially much purer than Thames water before filtration by the London Companies. Much stress was laid by Mr. Stimson, for the Corporation, on the fact that Bedford had not only escaped epidemics of enteric fever, but that the enteric fever mortality has been low for many years as compared with other towns in England and Wales. Evidence to this effect was given by Dr. Prior, Medical Officer of Health of Bedford, who put in a return of cases of enteric fever notified in the Borough from 1890–1903. The largest number of cases in any one year was 11 in 1901. Stress was also laid upon the lowness of the general death-rate in Bedford, but it has to be remembered that Bedford not only contains an exceptionally large population of school age, but also an exceptional number of families who merely reside in the town for a few years, whilst their children are being educated.

The opponents of the scheme deprecated reliance on any system of filtration, however excellent—Dr. Klein instancing the circumstances of Altona in 1894, and pointing out various ways in which filtration might fail to exclude pathogenic organisms.

They insisted that owing to the fissured nature of the Oolite contamination might be drawn from very long distances—this point was strongly insisted upon by Professor Dawkins. Dr. Klein was of opinion that the presence of B. coli in certain of the samples examined by Dr. Eastes (assuming these bacteria to have been typical B. coli communis) was a certain sign that pollution with animal excremental matter had occurred, and he combated some statements by Sir William Crookes that this organism is practically ubiquitous, and especially Sir William Crookes' assertion that it was present in saliva. Mr. Deacon urged that there might be less risk in drinking filtered Ouse water than filtered Oolite water, for the reason that the B. typhosus would (he assumed) be more likely to multiply in Oolite water than in river water, and the filtration in the case of the river water would be more efficient, as a scum would be more rapidly formed. The opposition also contended that the comparative immunity of Bedford from enteric fever in the past is no evidence that there is not a substantial risk from the present supply. All their expert witnesses were of opinion that a supply of deep well water from the Greensand would afford much greater safety than any filtered water from the present source.

Oddly enough, no objection to the Oolite water on the ground of its great hardness was made by the opposition. Dr. Stevenson, in reply to us, said that the Greensand water was softer (23 per 100,000 as against 33 to 40 in the present supply) and stated some economical advantages of softer water. He did not think there was any strong objection to the hardness of the Oolite water from the health point of view.

PART V.

PROPOSALS FOR IMPROVING THE QUALITY OF THE SUPPLY.

(*a*) Prevention of Pollution.

The Town Council propose to enter into an agreement with Mr. Franklin under which he will not in future "quarry stone," *i.e.*, the Great Oolite—or build either on the 15-acre brickfield north of the main heading, or on the higher ground on the East of Clapham Road, which he also owns. He also undertakes not to make any alterations in existing drains, &c., without the sanction of the Corporation, and to allow the Corporation to lay any drains they consider necessary. In a letter to the Surveyor of February 20th, 1904, since our inquiry was opened, Mr. Franklin adds that he is also prepared to undertake in future excavations to leave 2 ft. of clay above the "Pendle" (Cornbrash).

The Corporation further propose to cover up with clay all the places in Franklin's field in which the Great Oolite is at present exposed.

We are by no means satisfied that the proposed arrangement would satisfactorily achieve the purpose the Corporation has in view. It should be noted that besides the obvious places in which the rock is exposed there are several small hollows, the bottom of which must be very close to the Oolite, which might easily be overlooked, and these places are just those which might be chosen for casting rubbish or might be used by workmen for evacuation. Moreover, the undertaking to excavate clay only down to "two feet above the Pendle" is likely to be unsatisfactory in practice, as the first evidence of transgression would be coming on to the Pendle. In some parts of the field the "Pendle" is thin or broken, and might be overlooked, in which case the excavation of clay might continue down to the Great Oolite. And we have very grave doubts whether the considerable areas of exposed Oolite can be effectively sealed in the manner proposed. If they are not, there will be always risk of contamination from surface washings, especially as a considerable number of men are employed in brickmaking at the higher levels, and as a portion of the field is used as a vegetable garden. We were informed by one of the cottagers in the Clapham Road that his privy pails were emptied on this garden. The consideration to be paid to Mr. Franklin, including £1,000 for water rights, is £5,500. In view of the foregoing observations, however, we think it essential that the Corporation should buy this field altogether, and keep it entirely under their control. Apparently this field has been already worked out for brickmaking to a large extent.

No similar agreement is proposed as regards the Fairfield brickfield. As stated above (page 49) we do not think the excavations in this brickfield at present create any risk of pollution of the Oolite, and it is likely that the difficulty of removing surface water may prevent the excavations being carried deeper than they are at present. The Rev. Mr. Beckett, who has the lease of the Fairfield brickfield, stated at the inquiry that he had no intention of going down deeper, towards the Oolite, and he appeared as a strong supporter of the present scheme. Nevertheless it seems important that the Town Council should remember, in connexion with the cost of this scheme, that arrangements may be necessary to guard against the Fairfield brickfield being treated as Franklin's field has been.

Similar considerations apply to the fields north of Franklin's field, belonging to the St. John's Hospital Trustees and to Mr. Fitzpatrick, although, according to statements at the inquiry, there has so far been no proposal to use these lands for brickmaking.

(*b*) Filtration and Other Improvements Proposed.

Major Tulloch's proposals are :—

1. A battery of eight *pressure filters*, designed by the International Water Filtration Company, having a filtration medium

APP. A, No. 4. Bedford Water Supply; by Mr. Hooper and Dr. Buchanan.

of sand with layers of polarite interposed. Their object will be to purify and clarify the water before entering the settling reservoir. These filters will be placed on the rising main, 10 feet from the top, a head thus being available for washing out the filters, which is effected in a simple manner by reversing the flow. An arrangement is made by which air will be automatically drawn down into the body of the filter, the object being to supply oxygen to the polarite. The capacity of each pressure filter is stated to be 146,000 gallons per 24 hours.

Water after passing through pressure filters (1), will be treated either on filters (2) or on filters (3) :—

2. Two circular "*aerobic*" *filters* (area of each 675 square yards) with a filtering medium of sand and polarite 4 feet 3 inches thick.

These "aerobic" filters are to be worked by sprinkling arms rotating about 2 inches above the surface, after the manner of sprinklers in use on sewage filters.

The two temporary sand filters designed some two years ago by Mr. Deacon are to be superseded.

3. The three existing *rectangular sand filters* are to be so reconstructed, as to be fed intermittently from a series of wooden carriers, as in some sewage filters. The filtering medium is to be of sand and polarite some 3 feet thick.

The following area will thus be provided :—

	Square Yards.
2 New Circular Filters	1,350
3 Existing Rectangular Filters ...	1,103
Total	2,453

which on 1,000,000 gallons a day gives a filtration rate, with all the filters in use, of 408 gallons per square yard per 24 hours, or with allowance for cleaning and repairs (say 1 circular filter) 562 gallons per square yard per 24 hours.

4. *Other Improvements* at the Waterworks proposed by Major Tulloch are :—

(i.) The construction of a division wall across the settling reservoir, thus enabling one-half to be used at a time, to allow for cleaning and repairs.

(ii.) The drawing off of the water from the settling and storage reservoirs by means of floating arms instead of near the bottom as at present.

(iii.) The laying of a second 12 inch main 1,025 yards long from the storage reservoir to the Town, to safeguard the latter in case of accident to the existing one.

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Major Tulloch's proposals for filtration were subjected to considerable opposition at the inquiry. It will be convenient to deal first with the "aerobic" system proposed, and then with polarite.

Major Tulloch puts forward his "aerobic" proposals admittedly as a novelty in water filtration. He contends that work on the purification of sewage has made great strides, and that systems of water filtration have not been sufficiently considered in the light of results obtained from sewage treatment. By his proposals, in which the water to be filtered will not be under any head, he believes he will ensure free oxidation and bacterial action throughout the whole depth of the filter, with corresponding increase in efficiency. He did not express any definite opinion as to the probabilities of scum forming on the surface; it would be essential to his scheme that any considerable scum should be removed. The pressure filters would tend to reduce the formation of scum. We understand him to consider that purifying action would take place right through the filter, and would not, like the ordinary water sand filter, be dependent on surface scum. Major Tulloch did not bring forward any experimental evidence to establish a probability that this system of filtration would be efficient in the case of water in general, or in the case of a highly clarified water which had already passed through pressure filters in particular. One obvious point of difference between sewage filtration and Major Tulloch's "aerobic" filters is the character of he filtering medium. It seems not unlikely that fine sand might ail to afford a suitable lodgment for the nitrifying and other bacteria on which the success of the filtration would presumably depend.

Sir William Crookes, called for the Corporation, stated that he considered the proposed system of filtration an "excess of precaution." The "aerobic" proposal, however, was new to him, and his own view was that ordinary sand filtration, relying mainly on surface scum, was the most satisfactory process known. Professor Dewar gave evidence in the same direction. The opposition laid great stress on the fact that the formation of scum in the proposed filters was entirely a matter of conjecture, and brought forward evidence that, in ordinary sand filtration, this scum is essential to efficiency.

As regards polarite, Major Tulloch's object in providing this substance both in pressure and "aerobic" filters appears to be to increase the supply of available oxygen. Mr. A. Angell, Ph.D., Public Analyst of South Hants, stated that he had experimented with polarite (magnetic oxide of iron in combination with carbon) for many years, and found that, provided it was fully aerated, it continued for many years to exert an oxidising action on a number of chemical substances, including organic solutions. In reply to us, however, he said that he did not think the organic solutions of his experiments were sterile.*

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* We have received a letter since the inquiry from Mr. Angell, indicating the manner in which he believes that polarite acts as an oxidising agent, and giving details of an experiment to show that polarite may bring about oxidation of sterile organic matter.

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Mr. Candy (International Water Purification Company) said that polarite had been used with great benefit at the Reading Waterworks (River Kennett) for many years. The system at Reading involved passage of water through a large number of chambers, and the water filters through chambers containing sand before reaching the polarite. Pressure filters containing polarite had been adopted, with the Board's sanction, at Hastings, Leighton Buzzard, and elsewhere. It appeared, however, that the object of the filters in these cases is mainly to remove iron (Ashdown Sand Water at Hastings; Greensand water at Leighton Buzzard; Red Sandstone water, Teignmouth).

Sir William Crookes had no knowledge of the action of polarite; Professor Dewar stated that he did not know of any oxidising effect on organic substances without the aid of biological processes. The opposition brought forward instances where polarite was said to have been tried and found wanting in connection with the Vyrnwy supply to Liverpool, Mr. Candy replying that it had not been tried under proper conditions or on a sufficient scale.

The question of filtration was mainly discussed on the first day. On the second day Mr. Stimson, for the Corporation, stated that they did not rest their case upon the system of filtration proposed by Major Tulloch, and that if the Board advised the substitution of any other system of filtration the Corporation would be prepared to alter their scheme accordingly.

(3.) New Works in Hand.

On the 9th November, 1903, a contract was entered into with Mr. J. Johnson, contractor, for the carrying out of the following works at a cost of £6,855. This sum forms part of the £24,000 now applied for, and represents the work under contract No. 1.

i. The installation upon concrete foundation of No. 5 patent "pressure" filters.

ii. The construction of two circular aerobic filters.

iii. All necessary pipe laying, valves, &c., for the proper connection of the rising main to the pressure filters, and from thence to the settling reservoir and the filter beds.

These works at the time of our visit were well in hand, and we should infer that the Corporation had practically incurred liability for the whole amount of the contract.

The reason for commencing the works before sanction was obtained was stated by Mr. Stimson to be "on behalf of the safety of the town." The construction of these circular filters was strongly urged by Major Tulloch as an essential preliminary to any attempts to improve the existing supply for reasons stated on page 27 of his report. If the Board would not sanction the loan it would have to be paid for out of water revenue and rates. Before the termination of the inquiry, however, we were

advised that all the above works had been suspended pending recommendations from the Board in regard to the method of filtration to be adopted.

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PART VI.

PROVISIONS OF PRESENT PROPOSALS IN RELATION TO FUTURE REQUIREMENTS.

In the consideration of this point the present application appears manifestly weak. The proposed works cannot be regarded as even bringing the existing undertaking sufficiently up to date, still less as providing for the future, which is of vital importance to Bedford with its increasing population.

The rate of increase during the last four Censuses has averaged 27 per cent., and the 1901 population was an increase of 27 per cent. on that of 1891. Based, therefore, on 26 gallons per head the following will be the future demands :—

Year.	Population at 27 per cent. increase.	Daily Consumption.	Weekly Consumption.
		Gallons.	Gallons
1903	37,100	1,000,000	7,000,000
1913	47,100	1,250,000	8,750,000
1923	59,800	1,600,000	11,000,000
1933	76,000	2,000,000	14,000,000

Supply.—So long as the river can be drawn upon unrestrictedly, and no difficulties are met with from riparian owners, the question of quantity need not be considered. But if the river is not drawn upon it is extremely likely that further new headings may be called for.

Present Pumping Machinery.—Two pumps with a combined effective output of 1,633,000 gallons per 24 hours, which is 18 per cent. below the ordinary duplicate requirements.

Settling Reservoir.

Total capacity ... ... 1,250,000 gallons.
Effective capacity ... ... 628,000 „

This is only 63 per cent. of one day's supply.

Filters.—Proposed area 2,453 square yards, apparently for 1,000,000 gallons a day only.

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Service Reservoirs.—Two in number, having a combined effective supply of 350,000 gallons. This is only 36 per cent. of one day's supply.

Summary.

Pumping Machinery adequate (on duplicate requirements) for 82 per cent. of *one day's supply* of 1,000,000 gallons.

Settling Reservoir adequate for 63 per cent. of *one day's supply* of 1,000,000 gallons.

Service Reservoirs adequate for 36 per cent. of *one day's supply* of 1,000,000 gallons.

It did not appear to us that the Corporation were sufficiently aware of the deficiency of the provisions of their scheme for future years, and the point was not brought out by the opposition. Accordingly, on the third day of the Inquiry, we set out the above calculations. They were admitted to be correct. Mr. Stimson urged, however, that Bedford population is not growing so fast as it has been. The Town Clerk has since supplied figures as to new dwellings in Bedford, in support of this view.

New dwellings in	1900	...	...	318
„	1901	...	...	240
„	1902	...	...	187
„	1903	...	...	80

PART VII.

DETAILS OF CONSTRUCTION.—ESTIMATES.

Details of construction.—Having regard to the abandonment by the Town Council, at any rate for the time being, of Major Tulloch's filtration works, and to the fact that the issue of this Inquiry will follow the broad lines of the general question of water supply at Bedford, the details of construction have not been considered in this Report.

Estimates.—These have been given to the Board in detail; the summary is as follows:—

	£	s.	d.
Duplicate Main from Reservoir to Town	1,369	10	4
New Filter Beds	6,855	1	0
Alterations to existing Filters	4,977	19	5
Extension of Heading	919	14	0
Prevention of Waste	980	0	0
Compensation to Mr. Franklin	5,720	0	0
Engineering, Superintendence	1,661	0	0
Contingencies	1,510	15	3
Total ...	£23,994	0	0

Amount applied for, £24,000.

PART VIII.

OPPOSITION OF CLAPHAM.

Mr. Sharman, Clerk to the Bedford Rural District Council, stated that his Council had no desire to oppose the present scheme, but they asked for an understanding that if the Clapham wells were seriously or permanently affected by the proposed new heading, the Bedford Corporation would undertake to supply Clapham. The Chairman of the Clapham Parish Council gave evidence in support of this request.

Mr. Stimson, in reply, did not question that Clapham wells had been affected when headings were driven, but suggested that as the matter had then been set right by deepening some of the wells, this could be done again if necessary, and he further argued that as water comes from Clapham to the headings, the Clapham inhabitants should be able to get it first. The Corporation could not give the undertaking asked for, and he submitted that there was no legal ground for its being demanded.

So far as we could gather on inquiry at Clapham, the majority of the present wells go a very short distance into the Oolite, and some levels furnished by Mr. Deacon confirm this view. Probably before the headings were extended some of these wells barely reached the rock.

PART IX.

GREENSAND SCHEME.

We received some evidence as to the Greensand scheme which seemed material to the Inquiry. Under the scheme authorised by the Local Act of 1902, the Corporation have purchased a site for wells at Henlow, about 12 miles south of Bedford, at a cost of £1,500. This land is now leased. The cost of obtaining the Act was £1,500, so that £3,000 has already been spent on the scheme.

The scheme was designed by Mr. G. F. Deacon. No works have been begun at Henlow. The proposed wells would go through the Gault Clay (here believed to be from 50 to 150 feet thick) into the Lower Greensand. The supply was to provide for a population of 70,000 at 35 gallons a head, or 2,500,000 gallons per day.

No one at the Inquiry contended that it was unlikely that this quantity of water would be obtained from the Greensand. Mr. Deacon stated that at Edworth, about four miles from Henlow, a well had lately been sunk under his direction for the supply of Biggleswade. This well traversed 110 feet of "Ampthill Clay" and Gault before reaching the Lower Greensand. Extensive trials had shown that it is at present capable of yielding 3,000,000

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gallons a day. An analysis of this water was put in by Dr. Stevenson (Addendum III.). No question as to pollution or other objectionable qualities of the Greensand water was raised, except by Sir William Crookes, who said that it might be found to dissolve lead, but could adduce no facts whatever in support of this suggestion. The sample examined by Dr. Stevenson contained ·07 grain of iron per gallon, most of which was quickly deposited on settling.

We did not attempt to investigate the question of the cost of the Greensand scheme. The Corporation have power to borrow up to £135,000 under the Act. It was stated by Mr. Halliley that the estimated cost, providing for pumping at 2½ million gallons a day, was £66,000, and that very exaggerated statements of the cost had been made by the supporters of Oolite water. The Parliamentary estimate submitted by Mr. Deacon was for £85,000.

Supply of places on the line of mains.—The Act gives power to the Corporation to supply certain portions of Ampthill Rural, Biggleswade Rural, and Bedford Rural Districts. At the Inquiry no objection to the abandonment of the scheme was made on behalf of any of these districts. Mr. Marks, Clerk to the Bedfordshire County Council, appeared on the first day and vigorously cross-examined the Corporation's witnesses; he did not appear on the other two days or give us any information as to the views of the County Council on the matter. It is possible that some of the districts which were to have been supplied by Bedford may arrange to come into a large scheme of water distribution which we understand is being arranged in connection with the new Biggleswade supply.

PART X.

FINANCIAL.

The following Loans have been sanctioned by the Board :—

In 1863, 1866, 1869	£20,000	—all repaid.
In 1885	9,000	—£3,600 outstanding.
Total obtained from Loans ...	£29,000	
Estimated amount expended upon capital works and paid out of revenue	11,000	
Estimated capital cost	£40,000	
Amount still outstanding ...	£3,600	

Average amount of *surplus revenue* during the last six years placed to the relief of the rates, £2,046 per annum.

NOTE.—Liability incurred in contract now entered into £6,855, *see* page 58.

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PART XI.

CONCLUSIONS ON THE INQUIRY.

On review of the whole of the evidence, we think it clear that the scheme submitted, in its present state, is not one which the Board will wish to approve.

The objections to the scheme must to some extent be considered with reference to the Greensand proposals. It may be argued that as the Greensand scheme was considered and authorised by Parliament, only two years ago, it is now necessary that Bedford should show that its present proposals are not merely more economical, but also that they provide every bit as satisfactorily for the present requirements of Bedford, and for probable requirements in the near future. Assuming that the Greensand scheme would fulfil the expectations formed of it when the Act was obtained—and no evidence in the contrary sense is adduced by the Town Council—it must be admitted that the present scheme fails when judged on this basis. It is not certain that the present scheme will uniformly supply all the quantity of water needed, without recourse to the Ouse; the method of filtration proposed is novel, and until it has been tried must needs be open to considerable adverse criticism;* while as regards pumping plant, settling and service reservoirs, the scheme can hardly be regarded as even making adequate provision for the present population of Bedford, still less for its future population. Moreover, if all these objections were met, there would remain some balance of advantage in favour of the Greensand water in that its purity is not liable to be endangered by accidents in filtration, and also that it is not nearly so hard as Oolite water. If the above argument is accepted, it would seem necessary to refuse sanction, not only to the present scheme, but also to any improved scheme which depends upon the Oolite (or the Ouse) and filtration.

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* We would not be understood to imply that Major Tulloch's proposals are on wrong lines; our position is merely that the evidence is quite insufficient. The analogy with efficient systems of sewage purification is close enough to encourage a presumption that good results might in practice be obtained from Major Tulloch's "aerobic" system in the case of water. As to the scum contention, on which the opposition relied, it is obvious that the fact that surface scum is the effective agent in ordinary sand filtration is no evidence that surface scum is essential to all filters.

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The question may be presented, however, in another light. Can Bedford reasonably expect, by additions or alterations at its existing waterworks, to obtain a supply sufficient in quantity for present and near future requirements, and of a quality which may be considered satisfactory in the sense in which London or other waters which depend mainly on filtration for purity are satisfactory? We think this may be answered in the affirmative, but that the works necessary will be much more extensive and costly than the Town Council appears to believe. In regard to the prevention of waste, upon which Major Tulloch lays great stress, we are unable to advise the Board that it would occasion any conspicuous increase of the supply to the consumer, although some slight saving might be effected.

We would suggest that the most satisfactory way of dealing with the present application would be to indicate to the Town Council how far their proposed scheme is incomplete, and what additional undertakings would be necessary if their present system is to be satisfactorily altered and improved. It will then be the business of the Town Council to reconsider their position, comparing the cost of an improved Oolite scheme on the one hand with the Greensand proposals on the other.

If the Board adopts the latter view, we think the Town Council should be informed to the following effect :—

(1) That the Board would be prepared to sanction loan for the prevention of waste, on receipt of sufficient particulars concerning the nature and cost of the work proposed.

(2) That the Board are unable to sanction the loan for £24,000, as they consider the scheme submitted is defective in the following respects :—

(*a*) The proposed agreement with Mr. Franklin cannot be regarded as sufficient to protect the supply obtained from the headings against risk of serious contamination occurring in Mr. Franklin's brickfield. It appears essential that this field should be acquired by the Corporation and be kept wholly under their control.

(*b*) The system of filtration proposed (combination of "pressure filters" with the "aerobic" filters now in course of construction) is new in its relation to water supplies. Before considering the question of loan, the Board would require adequate experimental evidence as to its efficiency. The experimental work necessary for this purpose would include a series of day to day chemical and bacteriological observations, carried out over a considerable period. It is desirable that differential tests should be applied to determine the value to be attached to the provision of polarite in each kind of filter, and that the relative efficiency of the process

when applied to Oolite water, and to mixed water derived from the Oolite and from the river should be established.

(*c*) The working capacity of the present settling reservoir is only 63 per cent. and of the service reservoirs only about 36 per cent. of a present single day's supply of 1,000,000 gallons. It appears essential that much larger provision, both for settling and for storage of filtered water, should be made.

(3) The Inspectors report that if the scheme be amended to meet the objections (*a*), (*b*) and (*c*) above, there would remain a number of matters which are likely to demand attention in the near future, if a satisfactory supply is to be obtained. Thus :—

(*a*) It is not altogether certain that the proposed new heading will yield in dry seasons sufficient water to supply the population of Bedford in the immediate future. It is thus important that the possible need for additional headings—perhaps away from the present pumping well altogether—should be fully considered.

In this connection also it is essential to render it impossible that the supply should be supplemented from the Ouse in the haphazard way in which this has been done in the past. If the Town Council take the responsibility of adding to their supply by taking water from the river, the whole of the circumstances as regards the amount taken, hours of admission, and the like, should be carefully observed and recorded, and the efficiency of filtration in the case of the mixed water should be controlled by suitable experiments. In no case should river water be allowed to leak into the pumping well, as at present.

(*b*) Other fields near the river in the neighbourhood of the pumping station may be excavated for brick-making in a similar manner to Franklin's field, with the result of occasioning risk of pollution of the water drawn from the headings. It is important that the Town Council should bear in mind that it may in future be necessary to take steps to guard against this or other similar risk.

(*c*) The present pumps working in duplicate do not suffice to raise more than 1,633,000 gallons per 24 hours. It is evident that the need for additional pumping plant will arise at an early date.

(4) The Board understand that the principal reason adduced by the Town Council for abandoning the Greensand scheme authorised by the Bedford Water Act, 1902, is that a satisfactory supply can be obtained at much smaller cost by improvements at the existing works. In view of the considerations set out above, however, it is desirable to point out to the Town Council that, in

APP. A, NO. 4.

Bedford Water Supply; by Mr. Hooper and Dr. Buchanan.

the Board's view, a considerably larger expenditure than the £24,000 proposed under the present scheme would be necessary to obtain a supply in connection with the present works which could be considered satisfactory for Bedford, not only in the present, but also in the near future.

We have the honour to be,

Sir,

Your obedient Servants,

H. R. HOOPER,

G. S. BUCHANAN.

To the Right Hon. Walter H. Long, M.P.,
The President of the Local Government Board.

18th March, 1904.

PPLY.

F.I.C., 1

er 100.

No. 7. As it leaves filter bed taken 24th March, 1903.
Heavy rainfall previous day.
2·7
0·0320
0·0010
0·0075
0·0468
0·3302
23·0
35·5
12·5
23·0
54·0
Slightly turbid.
No smell. Some vegetable débris detected.

ADDENDUM II.

APP. A, No

Bedford Wa
Supply; by
Mr. Hooper
and Dr.
Buchanan.

ANALYSES HANDED IN BY SIR W. CROOKES.

Analyses of Bedford Waters. Parts per 100,000. Analysed by C. and D., February, 1904.

—	River Ouse	Heading from Adit level.	Franklin's Well.	Service Reservoir.	Tap in Town Hall.
Total solids	26·14	55·14	40·85	53·71	54·42
Cl	1·337	2·468	1·851	2·468	2·468
NaCl	2·191	4·045	3·034	4·045	4·045
Oxygen required..	0·285	0·061	0·117	0·067	0·071
N. as nitrates	0·000	0·000	0·000	0·000	0·000
N. as ammonia	0·000	0·000	0·000	0·000	0·000
Hardness before	20·30	37·63	31·25	36·97	36·65
Do. after	4·55	15·47	12·56	15·94	15·94
CaO	10·00	18·28	14·57	17·57	17·14
MgO	0·71	2·37	1·34	2·50	2·61
SO_3	0·	15·28	8·42	11·85	12·44
Organic C.	0·616	0·275	0·370	0·258	0·252
Organic N.	0·080	0·038	0·045	0·031	0·034
Microbes per cc.	9160	558	1800	35	36
B. coli, present in	30 cc.	No	30 cc	No	No
B. enteritidis present in ..	0·1 cc.	No	1 cc	No	No

. A, No. 4.
ord Water
ly; by
Hooper
Dr.
ennan.

ADDENDUM III.

ANALYSES HANDED IN BY DR. STEVENSON.

(a) *Sample of Water from River Ouse taken near Kempston.*

Kempston Urban District Council Water, per E. H. C. Inskip, 13th November, 1902.
Taken 11 a.m., 12th November, 1902.

Odour .. .. Very slight.
Colour .. .. None.
Turbidity—Slight; calcareous tog. débris.

—	Parts per 100,000.	Grs. per gallon.
Solids at 120°C.	37·6	26·32
Loss on ignition	5·2	3·64
Combined chlorine	3·3	2·23
Equal to common salt	5·26	3·68
Nitrogen as nitrates	Trace.	Trace.
Nitrites	None.	None.
Ammonia	0·0021	0·0015
Albuminoid organic ammonia	0·0222	0·0155
Oxygen required to oxidise organic matter	0·21	0·150
Hardness in degrees—temporary	19·9	13°·8
" " permanent	3·1	2°·2
" " total	23·0	16°·0

Number of bacteria per 1 cubic centimetre 294
Bacillus coli com. found in every 5 cubic centimetres examined.

(Signed) THOS. STEVENSON.

19th November, 1902.

(b) *Analysis of Greensand Water, made for the Biggleswade Water Board.*

Sample of Water received 31st December, 1903, from H. Home, Esq., for G. F. Deacon, Esq.

The water was free from odour, and when viewed in bulk, was colourless and slightly turbid: it quickly clarified by subsidence. The sample was stated by Mr. Deacon, C.E., to have been taken on 30th December, 1903, whilst the well was being pumped at the rate of about 750,000 gallons a day.

App. A, No. 1. Bedford Water Supply; by Mr. Hooper and Dr. Buchanan.

—	Grs. per gallon.	Parts per 100,000.
Total solids	26·60	38·00
Loss on ignition	1·68	2·40
Combined chlorine	1·09	1·56
Equal to common salt	1·80	2·57
Nitrogen as nitrates	Traces.	Traces.
Nitrites	None.	None.
Iron in solution	·014	·02
„ „ suspension	·056	·08
Total iron	·07	·01
Ammonia	·0085	·0121
Albuminoid ammonia	·0025	·0036
Oxygen absorbed	·024	·034
Temporary hardness	16°·4	23·4
Permanent „	2°·0	2·9
Total „	18°·4	26·3

These results show that the water is an excellent one, not unduly saline or hard, and most of the hardness due to calcium carbonate (chalk) removable by boiling. It is of a high degree of purity.

My special attention has been drawn by Mr. Deacon to the presence of iron in the water as possibly objectionable. The total iron in the sample was only $\frac{1}{14}$th grain per gallon, and not 20 per cent. of this, or less than $\frac{1}{70}$th of a grain per gallon, was in solution, the rest having apparently been deposited.

Evidently a very slight exposure has caused the deposition of practically all the iron, only an insignificant quantity remaining in solution, not more than is found in most non-ferruginous well waters.

As to the amount of deposited iron (0·056 grains per gallon), this amounts to only 8 lbs. per million gallons of water, or say 14 lbs. of deposited oxide. I understand that such oxide can by engineering expedients be readily prevented from entering the mains, in which case I expect no trouble will arise. It is unlikely that any deposit will occur therein, all the deposit being left in the reservoir.

Thos. Stevenson.

No. 5.

REPORT on the SANITARY CONDITION and ADMINISTRATION of the SPENNYMOOR URBAN DISTRICT; by DR. REECE.

In November, 1901, the Durham County Council made complaint to the Local Government Board that the Spennymoor Urban District Council had made default in providing sufficient sewers and otherwise in enforcing the provisions of sections 15, [illegible] and [illegible] of the Public Health Act, 1875. The County Council represented that the general death-rate, zymotic death-rate, and the infant mortality-rate were all higher in the Spennymoor Urban District than in the average of the Urban Districts of the Administrative County of Durham.

In October, 1902, the County Council made similar representation to the Board under section [illegible] of the Local Government Act, [illegible].

In consequence of these complaints, I was directed to make inspection of the Urban District of Spennymoor and to report to the Board on its sanitary circumstances and administration.

For this purpose I visited the district on 13th and 14th January, 1903. The night before my visit snow fell heavily and lay on the ground to the depth of several inches: I therefore after two days spent in the district decided to postpone further inspection until more favourable weather. I re-visited the district on 15th April. I should note that again snow fell on the night before my arrival and at intervals during the next few days, but this time it failed to lie, and did not therefore prevent the inspection.

At the time of the census in 1891, the area, number of inhabited houses, and population of the then Urban District of Spennymoor, formerly the Spennymoor Local Board District, was as is shown in the following table.

Table I.

Showing the Acreage, Number of Inhabited Houses, and the Population of the Spennymoor Urban District at the Census of 1891.

Urban District.	Acreage.	Inhabited Houses.	Population.
Spennymoor	168	1,135	6,041

The population in 1891 was thus about 36 persons to the acre. The rateable value was £12,626.

The area which then formed the urban district had on four occasions been inspected by the Board's Medical Inspectors and dealt with in reports, viz.: in 1874,* 1884,† 1885,‡ and 1889§, and it is alluded to in one of the Board's memoranda in 1895, as having an undue incidence of enteric fever.‖

The Local Government Board Order, No. 32,175, dated 20th November, 1894, confirmed with modifications an Order of the Durham County Council of 25th April, 1894, by which the Urban District of Spennymoor was extended to include parts of the Civil Parishes of Ferryhill, Merrington, Whitworth, and Tudhoe. The area thus added contained a larger population, and a very much larger acreage, and its rateable value was also greater, than the original Spennymoor Urban District.

The district is now divided into four civil parishes, and into three wards. The acreage, number of inhabited houses and the population of the district at the census of 1901 are given in the following table. The number of the population at the census of 1891 of the district now comprised in the Spennymoor Urban District, as extended in 1894, is given for comparison.

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* Dr. Thorne's Report to the Local Government Board on a Prevalence of Infectious Diseases in the Registration District of Auckland, and on the General Sanitary Condition of the District. 7th July, 1874.

† Dr. Parsons's Report to the Local Government Board on the Sanitary Condition of the Spennymoor Urban District, in reference to the prevalence therein of fever and other infectious diseases. 6th March, 1884.

‡ Dr. Page's visit in connexion with the Cholera Survey.

§ Dr. Page's Report to the Local Government Board on the circumstances of recent Prevalence of Scarlatina and Enteric Fever at Spennymoor, County of Durham. 15th March, 1889.

‖ Memorandum to the Local Government Board on the recent Prevalence of Enteric Fever in certain areas within the County of Durham; by Mr. T. W. Thompson. 25th September, 1895.

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TABLE II.

Showing the Civil Parishes and Wards of the Urban District of Spennymoor, with their Area in Acres, and the Number of Inhabited houses and the Population, Male and Female, of the Civil Parishes and Wards, and the whole District at the Census of 1901. For comparison, the Population at the Census in 1891 for the District as extended in 1894 is also given.

Area.	Acreage.	Houses, 1901.				Population.			
		Inhabited.	Uninhabited.		Building.	1891.	1901.		
			In occupation.	Not in occupation.		Persons.	Persons.	Males.	Females.
SPENNYMOOR URBAN DISTRICT.	3,388	3,205	105	43	9	16,363	16,665	8,393	8,272
Civil Parishes.									
Low Spennymoor ..	237	240	3	9	—	1,034	1,175	[illegible]	585
Merrington Lane ..	315	296	8		—	1,474	1,598	812	786
Tudhoe	1,853	1,429	25	16	1	7,653	7,652	3,825	3,827
Whitworth . ..	983	1,240	69	18	8	6,222	6,240	3,166	3,074
Wards.									
Ferryhill .. .	—	536	11	[illegible]	—	—	2,773	1,402	1,371
Spennymoor		1,204	69	18	8	—	6,052	3,081	2,971
Tudhoe	-	1,465	25	16	1		7,840	3,910	3,930

As now constituted the Urban District of Spennymoor forms portions of three registration sub-districts each in a different Registration District.

The inter-relation of the registration sub-districts, civil parishes, wards, and to some extent the distribution of the population is set forth in the following table.

The rateable value of the district is £37,431. The present general district rate is 1*s.* 6*d.* in the £ in Spennymoor Ward and 1*s.* 3*d.* in the "added area."

The Tudhoe Colliery pays rates on the colliery at a rateable value of roughly £4,000, the Binchester Colliery £1,000, the Iron Works £1,500, the North Eastern Railway Company £2,000 annually. The Tudhoe Colliery owns about 700, the Binchester Colliery 120, and Bell Brothers, Limited, 50 houses. There are no other companies owning houses in this district, but two private estates each own and pay rates on about forty houses. These companies pay on four-fifths of the rateable value of their houses, and they are allowed for empty ones. They do not compound for the general district rate as they do for the poor rate.

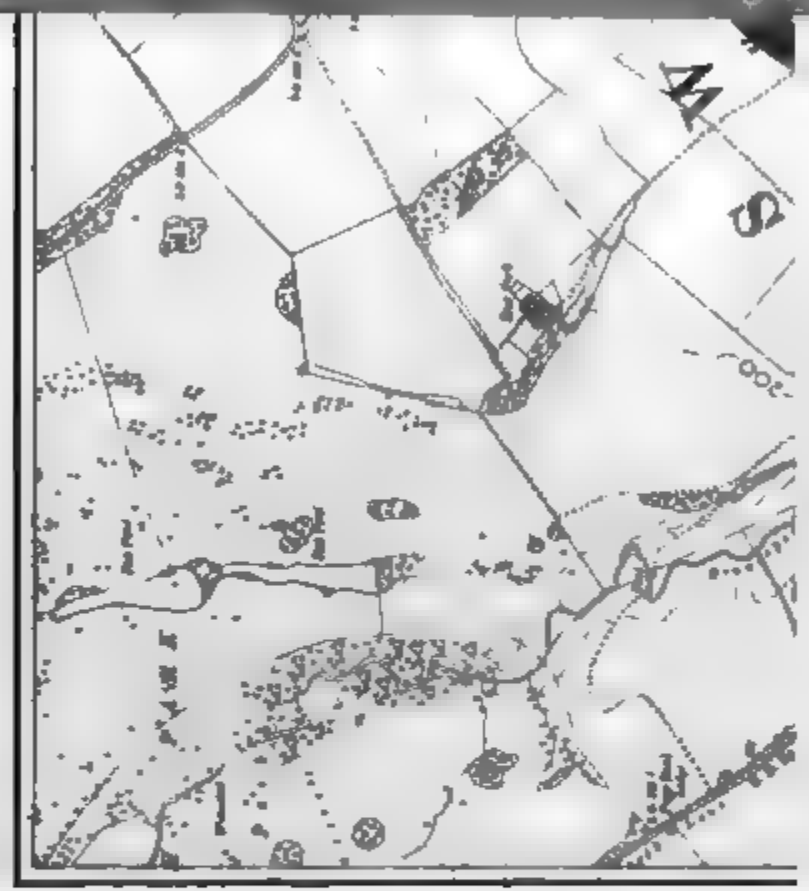
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TABLE III.

er-relation of the Registration Sub-Districts, Civil ards, and to some extent the distribution of the in the Spennymoor Urban District at the present

istration Sub-istrict.	Civil Parish.	Names of Places or Centres of Population.	Wards.
hops uckland.	Whitworth	Spennymoor village and a rural tract known as Whitworth Within.	Spennymoor Ward.
rnforth	Merrington Lane.	Merrington Lane	Ferryhill Ward.
	Low Spennymoor.	Low Spennymoor	
Oswald	Tudhoe ...	Tudhoe Grange...	Tudhoe Ward.
		Tudhoe Colliery	
		Tudhoe Village...	
		Mount Pleasant	

GEOLOGY.

ulder clay overlying the coal measures.

TOPOGRAPHY.

is undulating and somewhat bleak. Its aspect rom the park of Whitworth with its trees to the lag and refuse from the mines.

on is mainly grouped in five villages known as 'udhoe Grange, Tudhoe Colliery, Tudhoe Village, sant.

IEF INDUSTRIES OF THE DISTRICT.

dustries are coal mining, iron works, agriculture, d saw mills.

most important industry is coal mining. The ow mainly of the mining class. There are only within the urban district, viz., Tudhoe Colliery in

Tudhoe Ward, employing between 1,200 to 1,300 hands, and the Whitworth and Rock Collieries, both in the Spennymoor Ward, each when working employing some 20 to 30 men. Many of the inhabitants work outside the urban district at the neighbouring collieries. Some 150 men are employed at the blast furnaces at Tudhoe Iron Works. The iron industry has dwindled much of late years and some of the works have been closed. A number of the inhabitants are employed at the saw mills in cutting timber required for props in the mines. All the mines are working at present with the exception of the Whitworth Colliery.

ROADWAYS.

There are 29 miles of highways and dedicated roads, and two miles of undedicated roads. The highways are, as I am informed, made of 10-inch ballast covered with slag or dross from the iron works. The main roads through the district are well made, channelled and kerbed and well scavenged. The other roads of the district known as "Front" streets are not for the most part so well made, neither are they all channelled or kerbed and some of them are indifferently scavenged. Many of these front streets are wide, and in a few places young trees have been planted, but in too many instances the trees appear to have been wantonly destroyed. "Back" streets, which have been mainly constructed for carts to have access to the midden privies for the purpose of scavenging and for bringing coal to the houses, are often foul in the extreme.

At the date of my first visit it was impossible to ascertain the condition of the back streets owing to the snow. But on my second visit I found some back streets where some four inches of black filthy surface mud had been very recently removed. In these cases a made-up surface was to be seen. It was evident, however, that many of these back streets are inefficiently drained and channelled and badly scavenged, although from their very purpose they require and call for greater cleanliness than the front streets. In the process of cleaning out the contents of the midden privies and ash closets some portion of the filth necessarily falls on the roadway where it is liable to lie about, and the supply of coal, always abundant in a colliery district is brought in carts, &c., and shot down in the street on the same polluted surface to be shovelled into the coal shed at leisure; and thence brought into the house.

Both the old Spennymoor Urban District and the area added in 1894 have had a considerable amount of money expended upon the improvement of their streets.

The following table shows the loans sanctioned by the Local Government Board for this purpose in the Spennymoor Urban District.

TABLE IV.

Showing the Number, Date of Sanction, Amount, Period, Purpose, and the Area for which the sanction is granted for Loans for Street Improvement in the Spennymoor Urban District.

Date on which Sanction was Granted.	Amount.	Period for which the Sanction is Granted.	Purpose.	Area.
	£			
6th January, 1876 ..	450	10	Paving and channelling.	Old Spennymoor Local Board area.
6th January, 1876 ...	700	20	Paving and channelling.	
4th November, 1887	4,000	5	Private street improvement.	
22nd June, 1896 ...	2,000	6	Private street improvement.	
9th April, 1897 ...	1,000	10	Street improvement.	Mainly the area added in 1894.
22nd February, 1898	3,000	6	Private street improvement.	
28th April, 1899 ...	4,500	7	Private street improvement.	

On comparing, at the date of my visit, the condition of roads where street improvement had been carried out with the description given by the Local Government Board's Engineering Inspectors of the condition of the same roads at the time that sanction to loans was made the subject of local inquiry, I judged that very considerable advantage has accrued to the district through the work which has been carried out by means of the loans which are in question.

THE DWELLINGS OF THE WORKING CLASSES.

The greater proportion of the houses in the district are in good sanitary condition and repair and many that I inspected were well and tidily kept.

There are, however, houses which cannot be regarded as satisfactory from a public health point of view. Some few dwellings are so damp and dilapidated that action in regard to them under the Housing of the Working Classes Act is desirable. Again, there are back to back houses, and houses without windows or doors at the back which have all the drawbacks of back to back houses. And there are houses which have but one room, with a small cupboard opening from it, which is used as a scullery or larder. In such dwellings there is generally an attic under the tiles, approached from the living room by a ladder, but this room is often unceiled. From time to time the Medical Officer of Health reports of this class of house, and some of them have been altered so as to improve their sanitary condition, *i.e.*, the attics have been ceiled, &c. Overcrowding and all its attendant evils are almost

APP. A, No. 5.

Sanitary condition and administration of the Spennymoor Urban District; by Dr. Reece.

inevitable in such houses. Bad types of houses are to be found in Jackson's Street, Johnny's Row, &c. There is a certain amount of crowding of dwellings upon area in some of the older parts of Spennymoor where back yards are only a few feet wide.

Attention should be drawn to a common and very serious defect in most of the dwellings in the district. Many of the back yards are indifferently paved with porous brick, and in addition the bricks are often broken and the yard surface uneven; hence slop water and washings of the polluted surface of the yards lie ponded close to the back doors of the houses, which are the doors mainly used by the inhabitants, and thus foul matters of one and another kind are constantly being introduced into the dwellings on boots, &c., and by children.

There are several instances where the back yards are shared in common by the inhabitants of more than one house.

Courts as such scarcely exist, but there are certain places in the old parts of Spennymoor which for all practical purposes are courts.

Overcrowding of persons in houses was not specially obvious at the dates of my inspection. I am informed that the closing of a large iron works has caused some 800 to 900 workmen to leave the district recently, and hence any congestion that may have existed has been relieved.

THE WATER SUPPLY.

In the rural part of the district there are a few isolated houses supplied with water from wells, but the water supply of the bulk of the district is derived from the Weardale and Consett Water Company. This Company supplies nearly the whole of the western and northern portion of the County of Durham. The water is collected in the Weardale district, and is, I am informed, an upland surface water, which in its natural state has a tendency to dissolve lead. This is rectified by treating the water by means of lime. The length of lead piping is reduced to a minimum in the house connexions, and domestic supply pipes are usually of iron enamelled inside.

The water supply is constant, and there are practically no cisterns in the houses, other than in the few (about 30) which have water-closets, and then the cistern is merely a two-gallon flushing tank. The water is laid on to each house; in most instances it is carried inside the houses. There are only a few houses (*e.g.*, in Merrington Lane) which are supplied from standpipes. There are three houses in Whitworth Colliery which have no water supply, and the occupiers, by arrangement, fetch the water from a tap on a neighbouring main.

There is a local reservoir at Spennymoor, built many years ago on the hill side. Since its erection the town of Spennymoor has advanced out to it and past it. This reservoir is uncovered, and there is a black deposit on its sides. Land on a higher

level than the reservoir, and inside the containing wall of the Water Company's premises, is cultivated. Higher up the hill side are streets of houses, the natural drainage from which appears to be towards the reservoir. In these streets are many midden privies, from some of which soakage takes place into the ground. I could not ascertain that leakage took place into the reservoir from the ground above, but it is manifest that if the reservoir did leak there would also be an opportunity for the percolation of polluted ground water into it if the level of the water in the reservoir were below that of the ground water. This reservoir does not appear to be essential to the system of water supply to the district.

The supply to the district is stated to be ample in quantity, and the quality is said to be good.

Sewerage and Sewage Disposal.

The sewers appear nearly always to be of socketed glazed stoneware pipes with clay joints.

There are a series of sewers in the old Local Board District of Spennymoor—now the Spennymoor Ward—which have been laid piecemeal at various dates. Most of these were put down in the time of the Spennymoor Local Board. Only in two instances were sewers provided out of money borrowed under sanction of the Central Health Authority, and these were short lengths, viz.: in 1865 and 1878. The sewers laid down in 1865 consisted of 330 yards of brick culvert, 200 yards of segment tiles, and 800 yards of earthenware pipes.

In the added area there are pipes which receive sewage, but it is not possible to say to what extent they were originally constructed as sewers, or were intended to serve merely as surface-water drains. They are said to be glazed stoneware socketed pipes mostly having clay joints. None have been provided by money borrowed with the Board's sanction.

No complete plan of the sewerage was produced for my inspection, either for Spennymoor Ward or elsewhere. For the added area there exist certain plans of sewers for individual streets, but it is impossible without considerable excavation, to form an estimate of the extent to which this portion of the district has been sewered. Sewers cannot be traced by manholes, as these are few. Their ventilation is bad: when the cover of a manhole is lifted the smell arising from the sewers is offensive. To prevent egress of foul-smelling air from the manholes, most of them have had a sheet of iron or other substance placed over the opening to the sewers beneath the grids, or the detritus tray has been so fitted as to stop ventilation.

In the added area at Tudhoe Colliery there are one or two ventilating shafts, but they are too few in number to have any appreciable effect on the ventilation of sewers. No arrangement for systematic flushing of the sewers or drains exists in the district; the sewers are said to be occasionally flushed from a

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Sanitary condition and administration of the Spennymoor Urban District; by Dr. Reece.

water cart. In several of the manholes there where indications of silt probably caused by defective laying, faulty gradients, subsidence, or wrong calibres of pipes. Other evidences of faulty construction such as defective brickwork and pipe fitting were observed, and I heard complaints at various places of drains becoming choked or overflowing which did not seem to me to be altogether due to blocked gullies.

These sewers have numerous outfalls into the Tudhoe and Nicky Nack Becks, or into small streams feeding them, which are tributaries of the River Wear. The Surveyor professed ignorance of the position of these outfalls, save what is termed the main outfall at the disposal works for the sewage of Old Spennymoor, and the outfall of the main sewers from Tudhoe Grange and that from Tudhoe Colliery; but, with the assistance of Mr. Robinson, the County Council Inspector, I ascertained the position of a number of these outfalls.

The sewage disposal works of Spennymoor Ward, the old Local Board area, are on the banks of the Tudhoe Brook. The sewage is received into duplicate settling tanks and passes on to coarse bacterial coke filters, which are three in number. From the coarse filters the sewage passes to fine bacterial filters, and from these the effluent passes direct into the Tudhoe Brook. There is also a storm-water filter, but it was apparently not in use at the time of my visit. The measurements of the filter beds, &c., furnished to me at the inquiry by the Surveyor, I found on visiting the works, to be inaccurate. He has since prepared for me a plan of these works. On this plan the position of the storm filter is shown, but there is no indication given as to how the storm water can reach it nor how it can be discharged. I am doubtful whether, as a matter of fact, it can be used. Also no byepass or overflow pipe from the main sewage works is shown on the plan though I found that one existed. On the occasion of my first visit to the sewage works, of which my intention was only known to the Urban District Council and their officers an hour or so previously, the sewage was passing into the works. But it had snowed over night and it was still freezing, and it was evident that the sewage had only very recently been turned into the works. The Officers of the Authority present with me, the Clerk, the Inspector of Nuisances, and the Surveyor affected to be ignorant of the existence of the byepass, but through this byepass all the sewage had been discharged directly into the beck up to within a few minutes before my arrival at the works. Also on a second visit made to the works, at a time when there was considerable addition to the storm water from the melting snow, all the sewage was being passed directly into the Tudhoe Beck through the byepass.

On its way to, but some little distance from, the sewage disposal works, the main sewer is carried over a ditch, which opens a few feet further on into the Tudhoe Beck. As the sewer is carried over the brick arch, the side of the sewer is left open to permit of "flood water" finding a ready means of exit to the ditch. An iron plate inserted into the sewer here would, by turning the whole of the sewage into the ditch, or virtually into the beck, prevent any of it reaching the sewage disposal works.

No analysis of the effluent was available. But the County Council have made numerous complaints in connection with the pollution of the beck from these works, and it has been known for years that these were quite inadequate to deal with the volume of sewage from the population, roughly 6,000, of the district they serve. The District Council shelter themselves behind the plea that they do not wish to make fresh arrangements until the Royal Commission on sewage disposal has reported.

App. A. No. [illegible]

Sanitary condition and administration of the Spennymoor Urban District, by Dr. Reece.

Further down the Tudhoe Beck is another outfall sewer, a circular pipe 15 inches in diameter, from Tudhoe Grange, which is said to serve some 1,400 houses and 6,200 persons. It discharges sewage in a crude state directly into the beck.

Still further down the beck is the overflow pipe, 9 inches in diameter, from a brick tank 20 feet by 7 feet and 6 feet to 7 feet in depth. The sewage from the lower part of the Tudhoe village is received into this tank, which holds up the sludge, while the liquids pass on to the beck.

At Tudhoe Colliery village there is a settling tank, some 90 feet long, 15 feet wide, and 2 feet deep, built of brick, which receives sewage. The sewage which enters is made to traverse the length of the tank three times by means of two longitudinal partitions, and is discharged by a 9-inch pipe, to the Nicky Nack Beck. I learnt of the existence of this outfall from Mr. Robinson.

Also, in a field situated to the north-west of Tudhoe Colliery, and to the east of Tudhoe village, is a tank, 15 feet by 14 feet and of uncertain depth, covered over by wooden planks. The sewage settles in this tank, and the overflow passes by means of a 9-inch pipe into a tributary of the Nicky Nack Beck; or the sewage can be passed directly into the beck. The tank receives a portion of the sewage of Tudhoe village. This is another of the outfalls shown me by Mr. Robinson.

Again, at Tudhoe Colliery village there is a circular pipe, 2 feet in diameter, discharging crude sewage into the same tributary of the Nicky Nack Beck as that just mentioned. This pipe apparently brings the sewage from one portion of Tudhoe Colliery village.

In this neighbourhood the drainage from stables, stable yards, a slaughterhouse, lair, pigsty, &c., finds its way in a self-made channel to discharge into the beck by the side of the sewage pipe.

At Low Spennymoor, Ferryhill Ward, is a tank, 10 feet square and about 4 feet or so deep, roughly made of stones placed together without mortar, and covered over by planks on which earth is piled, which receives the sewage of this district. The tank is unventilated and is not watertight, but the surrounding soil is a retentive clay. The tank, which had about 3 feet of sediment at the time of my visit, overflows into a 12-inch circular pipe sewer laid beside the branch railway connecting Spennymoor and Ferryhill. After a while this pipe sewer becomes, for 250 yards, an open culvert, which eventually, by aid of a six-inch pipe passing under the rails, discharges into ditches on

either side of the railway line. These two ditches in turn discharge, about half a mile further on, into an unnamed beck, a tributary of the River Wear. This outfall was also shown me by Mr. Robinson.

I heard a rumour that still another outfall sewer existed, which discharged its contents into an old mining shaft. I failed, however, to find this outfall sewer.

In the course of certain of these sewers in the newly added area there are tanks or cesspits constructed for retaining the solid matter, the liquid passing on down the pipes. These tanks are roughly made of bricks or stones and are covered by planks with earth filled in over. They are said to be periodically emptied, and when it becomes necessary to open them the ground must be dug up. They retain putrefying sediment and add to the offensiveness of the sewers.

Thus in connexion with certain of the outfall sewers and in the course of some of the sewers, there are settling tanks of crude construction and of greater or less capacity; otherwise there is no treatment of sewage in the added area.

Tudhoe Beck as it flows between old Spennymoor and Tudhoe Grange is grossly polluted; filth of various kinds were seen in it.

Attention should also be drawn to the use made of the roadway gullies for disposing of slop water, &c. Loans of £2,000, £1,000, £3,000, £4,500 have been sanctioned by the Local Government Board for street improvements after local inquiries held in 1896, 1897, 1898, and 1899, and in each instance "surface water" drains have been provided in the roadways At the inquiry in 1896, in respect of a street improvement at Tudhoe Grange, it was stated by the district surveyor that a scheme of sewerage and sewage disposal for this portion of the district was about to be prepared. No scheme of sewerage or sewage disposal was, however forthcoming at the dates of the inquiries by the Board's Engineering Inspectors in 1897, 1898, and 1899, and after this last inquiry the Inspector, in reporting to the Board on the application, drew attention to the risk that the provision of these surface water drains would locally be allowed to serve as an excuse for neglecting to provide proper sewers. The Local Government Board sanctioned the loan asked for in respect of the street improvements at Merrington Lane and Low Spennymoor in 1899 on a receipt of an undertaking by the District Council that no house drain shall be connected with the surface water drains, and that all the joints of the surface water drains shall be made with cement.

So far as I could ascertain, no distinction is in practice drawn locally between sewers and surface water drains. Whether the pipe drains which receive the slop drainage from the gullies in back yards, &c., were originally laid as sewers or surface water drains I cannot say; but surface water drains are certainly in some measure utilised as sewers, as the Board's Engineering Inspector anticipated they might be. Slop water is habitually emptied into the road gullies at Mount Pleasant and in parts of Tudhoe Colliery village, and so it ultimately reaches the water

courses without undergoing any treatment, with the exception, perhaps, of that of subsidence in a settling tank of rudimentary construction.

Some rows of dwellings, as at Tudhoe Colliery village, are without sewers altogether, and where this is the case slop water is thrown into the midden or on to the ground, thereby increasing the fouling of the surface soil to which I have referred.

Branch drains as a rule appear to consist of glazed stoneware socketed pipes, with clay joints, carried round the backs of dwellings to gullies in the yards; these gullies are trapped.

There are few houses with any inside drains beyond sink waste pipes, which are usually cut off and discharge into the open air. There are only some 30 water closets in the district: new dwellings are habitually provided with ash closets, not with water closets.

In the circumstances above mentioned, it may be judged that want of proper sewerage tends to prejudice the health of the inhabitants of Spennymoor by reason of the general fouling of the ground which has thereby occurred, and also that serious pollution takes place of the River Wear through its tributaries. This has been the subject of repeated representations and complaints to the District Council by the County Council; and the Board, in 1899, drew the attention of the Urban District Council to the generally unsatisfactory condition of the drainage and to infringement of the Rivers Pollution Prevention Acts, and requested "that the matter may receive the immediate consideration of the District Council with a view to the preparation and submission to the Board at an early date of a suitable scheme for putting the sewerage and sewage disposal arrangements of the district on a satisfactory footing."

It is no doubt the case that the configuration of the district does not readily lend itself to a system of sewers which, while serving the whole area, shall deliver the total sewage to a single outfall. A single outfall is not, however, essential. The complaint of the County Council, which seems to be borne out by facts, is that the District Council have made no serious effort to attack the sewerage question, whether by a scheme of a single outfall sewer or of a series of outfall sewers along with disposal works where efficient purification of the sewage can be effected.

The *excrement* disposal of the district is by privy middens of the kind so common in the mining villages of the north of England. Many of these middens are of large size, uncovered, sunk below the surface of the ground, and uncemented on their inside; so that they allow of soakage into or from the soil. In some instances where middens are near dwellings, or where there are no yard gullies handy, the slop water, urine, &c., are thrown into them, and many middens are so constructed that the rain water from the roofs of the privies, &c., drains directly into them. Some are so arranged that two to four privies discharge into one midden. Many privy-middens of the old type have been altered; they have been partly covered in at the sides and supplied with

roofs; and others have been replaced by the so-called ash closet. The ash closets which form about five per cent. of the privy accommodation in the district are to be seen principally in Spennymoor ward, and they are said to be adopted in connection with all new houses. The seat of such ash closet lifts up, and the ashes, &c., are thrown into a sort of tank under the seat, to which an outlet is provided, generally behind in a back street, for the contents to be emptied by the scavenger. These midden privies are often placed near to the pantries and back windows of the houses in close and confined back yards.

In some parts of the district there are practically no back yards, and the midden privies and coal sheds form a long line of buildings erected between the backs of two rows of houses. There are rows of such midden privies at Tudhoe Colliery village, and at Mount Pleasant.

The midden-privies of the greater number of the schools have been erected so that the midden is between two rows of privies, the midden with its associated privies being covered by a single roof. At either end of the midden is an aperture through which ashes may be cast into it, and by way of which the midden contents may be cast out in cleansing operations. The floor of the midden is generally sloped to permit of the liquids running to the central channel. From the construction of these middens it is almost impossible to cause the excrement to mix with the ashes, which are only just thrown in, so that they fall near the entrance doors. The strong objections to this class of privy midden at schools have been commented on by the County Medical Officer of Health in one of his Reports on Spennymoor.

Scavenging.

For scavenging purposes the district is divided into 12 divisions, each of which is under separate contract. The total sum paid is nearly £700 per annum. The contractors agree to do the work "according to the directions and to the satisfaction of the Inspector of Nuisances for the time being of the said Council, and so that each ashpit shall be emptied once in each lunar month or oftener if necessary, and also that each earth closet shall be emptied twice in every week, or oftener if necessary, and when required by the Inspector of Nuisances."

As a general rule the scavenging was fairly well performed, but there were many instances observed where both the large privy middens and the ash closets were full to overflowing. The necessity for constant supervision of the work was evident.

There is no refuse destructor in the district, and the contractors dispose of the contents of the midden privies and ashpit privies when and how they can.

Nuisances.

It is impossible to go far in the inhabited part of the district without coming upon obvious nuisances. For the most part nuisances are of the kind inevitably associated with the uncovered

and faultily-constructed midden-privies, even when their cleansing is systematically effected. But there are undrained cowsheds and stables, and, as I have already said, there are damp and dilapidated houses, and defective paving to back-yards, which give rise to obvious and serious nuisances.

The existence of certain of these nuisances, I was informed, had been brought to the notice of the District Council from time to time, but no adequate steps had been taken to deal with them. It appeared to me that the action of the Council had been mainly concentrated on dealing with the ever-recurring nuisance of the overfull midden-privy; indeed, the time of the Inspector of Nuisances must be very fully occupied in supervising the emptying and cleansing of these objectionable places by the scavengers, and such action as has been taken with regard to these middens has often done little to abate the nuisance. In recent years many of the middens have been roofed over, but so far as could be ascertained, their floors have not been raised above the ground level, nor have they in underground structure been made watertight. Many middens have been replaced by "ash closets," which is in one sense a gain, as the amount of refuse and excrement that can in each instance be stored is limited to a comparatively small space under the closet seat, but the gain may be counterbalanced by increased fouling of the surface of the back streets, due to more frequent removal. This depends on how the work is done.

What is wanted is a more general use of the powers, which under the provisions of the Public Health and other Acts, are entrusted to the District Council, in their capacity as the Sanitary Authority of the District. Routine inspection of the district for the discovery of nuisances should be carried out thoroughly and systematically with a view to ascertain what nuisances exist calling for abatement under the powers of the Public Health and other Acts. It is the duty of the District Council to enforce the abatement of such nuisances (Public Health Act, 1875), section 92, and this independently of complaints from inhabitants. In the case of nuisances likely to recur, the District Council should not rest satisfied with their mere abatement for the time being, but should require the execution of such works as may be necessary to prevent their recurrence, and failing compliance should take legal proceedings in accordance with sections 95 and 96 of the Public Health Act, 1875.

Common Lodging Houses.

There are only three registered common lodging houses in the district, all in the Spennymoor Ward. The general condition of one is fairly good, of one indifferent, and of the third the surrounndings were bad. The back yard of this latter house is only a few feet in width and the paving is defective. In it there are two dilapidated privies opening to a common midden the walls of which were leaky, and there was a tub of stinking slush for pigs' food under tbe windows. A fowl-house, a wash-house, and what did duty as a urinal, were also crowded into this narrow yard.

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Mr. Joseph Elliott, Inspector of Police, Spennymoor, is paid a salary of £10 per annum by the Urban District Council for inspecting and reporting on these three houses.

None of these houses comply with the Council's own Byelaws regulating Common Lodging Houses.

There is no separation or partition between the beds allotted for married couples, and adult "single men" are allowed to sleep two in a bed, the byelaws to the contrary notwithstanding. The latter practice appears to have the written assent of the Urban District Council, for in the sleeping rooms are hung printed cards bearing the heading "Spennymoor Urban District Council—Rules and Regulations for Common Lodging Houses." On these cards the total number of lodgers that are to be received in the house is filled in in ink, the number of the room quoted, and the number of persons to be received in that room. As an instance, in one room occupied by single men the card displayed has the following written on it in red ink:—"Room No. 5: four Beds, eight persons allowed in this room." These notices have printed at their foot, "By order of the Council, F. Badcock, Clerk to the said Council."

Dairies, Cowsheds, and Milkshops.

There are some 39 registered milk sellers.

The Urban District Council has adopted and issued a set of Regulations for Dairies, Cowsheds, and Milkshops, but these regulations have not been enforced.

In the cowsheds visited, cows in excess of the number for which they are registered were in some instances found; some of these sheds are dark, unventilated, and undrained, and quite unfitted for keeping cows in; nearly all were in a dirty condition.

It is useless to expect improvement without proper inspection by the Inspector of Nuisances, and without action by the District Council, who at present appear to be neglecting, in this important matter, to protect the health of their district. Fœcal pollution of the milk must occur with great frequency in these filthy cowsheds, and the introduction in this way of various harmful organisms into the milk, may in a measure account for the high death-rate, not only among babies but also among adults, attributed to "diarrhœa" in this district.*

Slaughter Houses.

There are some 31 registered slaughter houses in the district, and the District Council has adopted byelaws regulating slaughter houses. Those visited by me were in a fairly clean condition. But in some cases the lair adjoined the slaughter house, and was

* In this connexion the virulent pathogenic properties of the bacillus enteritidis of Gaertner—an organism found in the intestine of the cow—may be alluded to.

inefficiently drained. Cases were also seen where the lair was in use as a stable, and in several slaughter houses were kept articles, which should not be found in places set apart for slaughtering, such as sausage machines. Preparing meat for sale in places used for slaughtering and dressing carcases has before now been associated with serious food poisoning. In this matter again competent inspection is necessary.

Bakehouses.

I am informed that there are in the district only three bakehouses, of which one is registered and two are not. The bulk of the baking is done at the homes of the people.

Isolation Hospital.

On the Durham County Council putting into operation the Isolation Hospital Act, 1893, and proposing to combine districts in this part of Durham for hospital purposes, the Spennymoor Urban District Council decided to erect a hospital of their own for the isolation of infectious diseases. This was built by moneys raised on a loan sanctioned on 6th October, 1899, by the Local Government Board, after local inquiry.

The hospital is situated at the south-west end of the district. It consists of two pavilion blocks, containing 12 beds in four wards, and is thus capable of accommodating at the same time two separate diseases in both sexes.

There is a laundry block containing a wash-house, and ironing room, a disinfecting apparatus, an ambulance shed, and a mortuary. There is an administration block, in which the superintendent nurse, the caretaker, and his wife live, and besides these quarters there are rooms available for nurses. The caretaker is an ex-miner; his wife does the washing for the hospital.

There is a galvanized iron building on land adjoining the isolation hospital, which was erected under fear of extension of small-pox from Middlesbrough some years ago. This, it was stated at the local inquiry held in August, 1898, was to be used as the caretaker's cottage; but it is now occupied by one of the workmen of the Urban District Council.

Before inquiry was held into the application for loan to erect the isolation hospital, the plans had been the subject of much correspondence between the Local Government Board and the District Council. The plans originally submitted were faulty in many respects, and the Board, by correspondence and by inviting conferences at Whitehall, endeavoured to assist the Council as much as possible in arranging a suitable scheme. Amendments were made in some respects and others appeared called for as a result of the local inquiry held by Dr. Mivart in August, 1898—notably as regards the sufficiency of the land area which it was proposed to use; as to the nature of the estimates submitted,

which did not appear to be sufficiently prepared; and as to the details of the plans which were still incomplete. It was not until October, 1899, and after much correspondence, that the Board were able to consider the plans sufficiently satisfactory to warrant them in granting sanction to the loan of £3,500 applied for. This sanction was given subject to an undertaking that small-pox would not be treated on the site at the same time as other infectious diseases. In April, 1902, the District Council obtained the Board's sanction to loan for additional £1,000 for the completion of the hospital, and for the purchase of land adjoining the site. Reasons had first been given by the District Council for the contracts having exceeded the estimates by some £600—one of these reasons being that the designed system of sewerage had been found impracticable on account of the levels. It was also stated that a sum of £437 was required to complete the purchase of 4 acres 14 perches of land so as to allow for future extension of the hospital.

I visited the hospital in April, 1903, and since then have had an opportunity of comparing my notes with the revised plans on which the Board's sanction to loan was given. The plans, and undertakings given by the District Council as a condition of sanction, have been departed from in several particulars, for example :—

Three sides only of the site have been enclosed by a closed fence 6 feet 6 inches high, not all four sides as stated.

The inside walls were simply distempered and not painted as stated. Corners and angles which were to have been rounded off have been left square.

Slop sinks, which were to have been provided, are absent, and the efficiency of the wards suffers in consequence. Ordinary wash-hand basins, which do not serve the purpose, have been provided instead.

No gullies are provided for emptying baths as stated.

The laundry roof has no louvre ventilator as stated, and there is no other escape provided for the steam. This laundry was full of steam at the date of my visit, and a great nuisance was caused by steam wetting everything.

The boiler-house is without ventilation, and its window, made to open, was not fitted with cords and weights, and was nailed down.

The mortuary is undrained and unventilated.

Ventilating shafts of soil pipes have two nearly right-angled bends in their course.

Most of the deviations from the sanctioned plans which I noticed have tended to impair the efficiency of the hospital, and it is a matter for regret that greater care was not taken in erecting an institution which the District Council have found to cost so much more than they originally estimated.

AMBULANCE.

There is a new pattern horse ambulance fitted with two stretchers kept at the isolation hospital. The ambulance is horsed by contract.

MORTUARY.

Except that at the isolation hospital there is no mortuary in the district.

DISINFECTING APPARATUS.

The disinfecting apparatus at the isolation hospital is a steam apparatus made by Messrs. Thomas Bradford & Co. The caretaker of the isolation hospital has charge of and works this disinfecting apparatus. It is desirable that he should wear a special suit of clothes or covering while engaged in this work. The caretaker brings the infected articles to the isolation hospital in the ambulance; the articles when disinfected are removed from the hospital in ordinary carts.

CEMETERIES.

There is one cemetery for the Spennymoor Ward provided out of moneys paid by the "added area" to the old Spennymoor Local Board area. Burials have ceased in the parish churchyard. The Tudhoe Burial Board was taken over by the Spennymoor Urban District Council on the extension of their area in 1894, and the cemetery established by that Burial Board serves for the portion of the Spennymoor Urban District comprised in the "added area."

ADOPTIVE ACTS AND BYELAWS ADOPTED IN THE DISTRICT.

The Adoptive Acts, and the Byelaws which have been adopted in this District, are shown in the following Tables.

TABLE V.

Showing the Adoptive Acts adopted in the Spennymoor Urban District, and the Date of the commencement of each Act.

Acts.	Date of Commencement.
Infectious Disease (Notification) Act, 1889	1st January, 1890.
Infectious Disease (Prevention) Act, 1890	1st March, 1894.
Public Health Act Amendment Act, 1890, Parts III. & V.	1st March, 1894.
Private Streets Works Acts, 1892	1st March, 1894.

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Table VI.

Showing the Byelaws in force in the Spennymoor Urban District, and the Date of Sanction of the Byelaws.

Byelaws.	Date of Sanction.
Nuisances	22nd September, 1885.
Common Lodging Houses	22nd September, 1885.
New Streets and Buildings	22nd September, 1885.
Markets	22nd September, 1885.
Slaughter Houses	22nd September, 1885.
Cleansing of Footpaths and Pavements adjoining any premises.	22nd September, 1885.
Park	14th August, 1897.

Since the year 1898 the Urban District Council has been engaged in revising their series of byelaws, but as yet they have not submitted a final proof to the Board for confirmation.

Officers of the District Council.

The Medical Officer of Health.—Dr. Robert Smail Anderson, M.D., Edin., who has been resident in the district since 1877, was appointed to the office of Medical Officer of Health on 26th March, 1896. On the occasion of his appointment the District Council took the opportunity of reducing the salary of their health officer from £100 to £75, on the plea that there was less work to do in the district than formerly. Dr. Anderson's annual reports show that from year to year he has carefully set forth the condition of his district, that he has drawn attention to several of its sanitary requirements, and that he has tendered well-considered advice for the guidance of the District Council. Acting under his advice, the Council in 1899 issued a leaflet on "Hints about the feeding and management of children," with a view to diminish the enormous mortality among infants in the district. But unfortunately, the Council have not always taken advantage of the reports of their Medical Officer of Health.

Recently Dr. Anderson has been appointed Medical Superintendent at the Isolation Hospital. He is to control the administration, attend the sick, and supply all medicines. For this the remuneration suggested by the District Council is £20 per annum, or 1s. 1½*d.* a day; less, be it noted, than the District Council pay to the Police Superintendent for each weekly visit to a common lodging house! At the time of my visit there were in hospital several cases of scarlet fever, and two patients, requiring constant care and attention, very ill with typhoid fever.

Obviously the payment to Dr. Anderson for hospital work and for duties performed as Medical Officer of Health calls for reconsideration by the District Council.

The Inspector of Nuisances.—On 15th January, 1903, the Urban District Council proceeded to elect an Inspector of Nuisances. The officer appointed was to devote all his time to the duties of his office, and to receive a salary of £110 per annum. The County Council were expected to repay half this salary.

I am informed there were 123 candidates, of whom 82 held a certificate of competency in sanitary knowledge granted by the Sanitary Institute or by some similar body. The Council elected Mr. Arthur Dowdell, aged 38, a miner, and who at the time of his appointment was, and had been for eight years, a member of the Council, and for the past two years chairman of the Works Committee. Mr. Dowdell holds no such certificate.

The Local Government Board refused their sanction to this appointment.

The Clerk.—This office is filled by Mr. Frederick Badcock, a solicitor, who lives at Bishop Auckland.

The Surveyor.—Mr. Charles Robert Spencer was appointed Surveyor in December, 1901. Antecedent to his appointment he had been Surveyor to the Horbury Urban District Council (Yorks) for eight years, prior to which he was assistant in the office of the Borough Surveyor at Batley. He devotes the whole of his time to the duties of his office, and receives a salary of £180 per annum.

Health and other Statistics of the District.

Part of the complaint of the Durham County Council against the Spennymoor District Council is that the general death rate, the zymotic death rate, and the infant mortality rate were all higher than in the Urban Districts of the Administrative County of Durham. They did not however supply the Board with the figures for the urban districts in the county, upon which this comparison was based.

The old Local Board of Health District, now the Spennymoor Ward, which had at the Census of 1891 a population of 36 persons to the acre, and on the insanitary conditions of which my colleagues have previously reported, had and still has, as is shown in the Annual Reports of the Medical Officer of Health, an unenviable notoriety in this sense. But the district as a whole now comprises a considerable area which is practically rural, and which should, by the lowness of its death-rates, considerably counterbalance those of the more congested portions; and hence the figures for the whole district may fairly be compared with those for the whole Administrative County of Durham comprising both Urban and Rural Districts.

APP. A. No. 6

Sanitary condition and administration of the Spennymoor Urban District; by Dr. Reece.

TABLE VII.

Showing for the Years 1896–1902 inclusive the Estimated Population in the Spennymoor Urban District, with the Number of Births and the Birth-rate, the Number of Deaths at all Ages and the All Age Death-rate, the Number of Deaths under One Year of Age and the Infantile Death-rate; together with Number of Deaths occurring each Year which were Uncertified by a Registered Medical Practitioner, and the proportion that these uncertified deaths bear to the Total Number of Deaths Registered.

Year.	Estimated Population.	Births.		Deaths.					
				All Ages.		Under One Year.		Uncertified.‡	
		Number.	Rate per 1,000 Population.	Number.	Rate per 1,000 Population.	Number.	Rate per 1,000 Births.	Number.	Percentage Uncertified of Total Deaths.
Census 1891	*16,383*								
1896	16,530	620	37·5	337	20·4	118	190	100	29·8
1897	16,559	632	38·2	288	17·4	104	164	64	22·4
1898	16,586	652	39·3	345	20·8	141	216	76	22·3
1899	16,615	667	40·1	395	23·8	149	223	82	22·1
1900	16,643	664	39·9	332	19·9	110	165	81	24·4
Census 1901	*16,661*								
1901	16,672	654	39·1	415	24·9	153	233	92	22·2
1902	16,700	656	39·2	292	17·5	106	161	78	26·7
Average for 7 years, 1896-1902 inclusive.	16,615	649	39·1	343	20·7	126	194	83	24·2
Average for 7 years, 1896-1902 inclusive, for the *County of Durham.**	—	—	35·3	—	18·1	—	165	—	2·9
Average for 7 years, 1896-1902 inclusive, for *England and Wales.*†	—	—	29·0	—	17·4	—	152	—	1·93

* The figures for the County of Durham are those given by the Medical Officer of Health in his Annual Reports for the years 1896-1901; those for 1902 are calculated on the Registrar-General's Quarterly Returns.

† The latest issued Annual Report of the Registrar-General is that for the year 1900, consequently the Rates given in the Quarterly Returns for the years 1901 and 1902 have had to be utilised in completing the period of seven years.

‡ See footnote * to Table IX.

This table shows that for the seven years 1896–1902, inclusive, the average general district mortality rate for the Spennymoor Urban District, as now constituted, has considerably exceeded that for the County of Durham, and has been greatly in excess for the corresponding rate for England and Wales. Also it shows that the Spennymoor death-rate for infants under one year of age during the same period has also been much greater than the corresponding rate for the County of Durham and than that for England and Wales.

In the case of a district situate as is the Spennymoor Urban District, it is important that the "fever"* death-rate, the diarrhœa and enteritis death-rates should be considered. Accordingly I have made a table which gives the "fever" death-rate and "fever" notification rate, and the diarrhœa and enteritis death-rate, and which is also arranged to show the proportion of deaths of infants from these latter diseases. I have also added the phthisis death-rate.

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* "Fever" in this sense includes "typhus fever, enteric or typhoid fever, relapsing fever, and continued fever."

TABLE VIII., showing for the Years 1896–1902 inclusive for the Spennymoor Urban District the Number of Notifications and Deaths from "Fever," and their Rates per 1,000; the Number of Deaths and the Death Rate, from Diarrhœa and Enteritis at All Ages, and the Number of these Deaths under One Year of Age; also the proportion of Deaths from Diarrhœa and Enteritis under one year to the total deaths from these causes at All Ages and to the Number of Births Registered. The Number of Deaths from Phthisis and the Phthisis Death-rate are also given.

Year.	Estimated Population.	Fever.				Diarrhœa and Enteritis Deaths.					Phthisis at All Ages.	
		Notifications.		Deaths.		All Ages.		Under One Year.				
		Number.	Rate per 1,000.	Number.	Rate per 1,000.	Number.	Rate per 1,000.	Number.	Percentage of Diarrhœa and Enteritis Deaths at All Ages.	Percentage of Births Registered.	Number of Deaths.	Death-rate per 1,000.
Census, 1891	*16,383*	—	—	—	—	—	—	—	—	—	—	—
1896	16,530	19	1·15	3	0·18	19	1·15	17	90·0	14·4	15	0·91
1897	16,559	23	1·39	3	0·18	8	0·48	7	87·5	16·7	22	1·33
1898	16,586	42	2·53	9	0·54	30	1·81	28	93·3	19·8	20	1·21
1899	16,615	35	2·11	10	0·60	38	2·29	36	94·7	24·1	21	1·26
1900	16,643	28	1·68	6	0·36	33	1·98	23	69·7	20·9	18	1·08
Census, 1901	*16,661*	—	—	—	—	—	—	—	—	—	—	—
1901	16,672	13	0·78	2	0·12	60	3·60	37	61·7	24·2	14	0·84
1902	16,700	9	0·54	2	0·12	18	1·08	14	77·8	13·2	21	1·26
Average for the seven years 1896–1902 inclusive.	16,615	24	1·44	5	0·30	29	1·75	23	79·4	18·2	19	1·14
County of Durham Urban Districts.†	—	—	1·35	—	0·20	—	1·43	—	—	—	—	1·26
England and Wales‡ ...	—	—	—*	—	0·17	—	0·75	—	—	—	—	1·33

* Not obtainable.

† Figures supplied by the Medical Officer of Health for the County of Durham.

‡ See corresponding footnote to Table VII.

This table shows that the death-rate from fever in the Spennymoor Urban District is 50 per cent. in excess of that of the urban districts in the Administrative County of Durham and is nearly twice as great as that for England and Wales, and that the Spennymoor diarrhœa and enteritis death-rate at "all ages" is higher than that for the urban districts in the Administrative County of Durham, and nearly three times as great as that of England and Wales. The "notification" rate of fever in Spennymoor Urban District is lower than would be inferred from comparing the fever death-rate in Spennymoor Urban District and in the urban districts in the Administrative County of Durham. This is probably due to the defect of notification of infectious diseases brought about by unqualified medical practice. On the other hand the phthisis death-rate is lower in Spennymoor Urban District than in the urban districts in the Administrative County of Durham or in England and Wales.

Uncertified Deaths.

The general death-rate and the infantile death-rate of Spennymoor are probably reliable, but, as I have shown in a former table (VII.), the number of uncertified deaths in this district amounted on an average of seven years ended 1902, to something just short of a quarter of the whole number of deaths registered. In consequence the accuracy of the detailed causes of death must in great measure be open to question. The following table illustrates the conditions under which deaths pass uncertified in this district.

TABLE IX.,* showing for the Spennymoor Urban District the Total Number of Deaths at All Ages, the Number of Deaths uncertified by a Registered Medical Practitioner, the Percentage of the uncertified Deaths to the Total Number of Deaths at All Ages, the Number of Deaths uncertified as the result of unqualified Medical Practice, the Percentage of the Deaths uncertified as the result of unqualified Medical Practice to the Total Number of Deaths at All Ages, the Total Number of Deaths under 5 years of age, and the Number of Deaths under 5 years of age uncertified as the result of unqualified Medical Practice, the Percentage of Deaths under 5 years of age uncertified as the result of unqualified Medical Practice to the Total Number of Deaths under 5 years of age; also the Total Number buried on the Coroner's certificate without Inquest, the Number buried on the Coroner's certificate without Inquest under 5 years of age, the Number of Inquests held, and the Percentage of Inquests to the Total Number of uncertified Deaths. The Percentage of uncertified Deaths to the Total Number of Deaths at All Ages for the County of Durham and England and Wales are added for purposes of comparison.

Year.	Total Deaths at All Ages.	Number of Deaths uncertified by Registered Medical Practitioners.	Percentage of uncertified Deaths to the Total Deaths at All Ages.	Number of Deaths uncertified as the result of unqualified Medical Practice.	Percentage of Deaths uncertified as the result of unqualified Medical Practice to Total Number of Deaths at All Ages.	Total Number of Deaths under 5 years of age.	Number of Deaths under 5 years of age uncertified as the result of unqualified Medical Practice.	Percentage of Deaths under 5 years of age uncertified as the result of unqualified Medical Practice to Total Number of Deaths under 5 years of age.	Total Number buried on the Coroner's certificate without Inquest.	Number buried on the Coroner's certificate without Inquest under 5 years of age.	Number of Inquests held.	Percentage of Inquests to Total Number of uncertified Deaths.
1896	336	100	29·8	95	28·2	177	67	37·9	8	—	15	13·0
1897	280	84	22·4	64	22·2	138	46	33·3	9	2	3	4·7
1898	345	76	22·3	73	21·2	194	43	22·2	7	2	9	11·7
1899	304	93	22·1	77	19·5	221	60	27·1	5	—	10	11·5
1900	332	81	24·4	63	19·0	158	37	23·4	18	2	6	7·4
1901	416	92	22·2	87	21·0	236	51	22·6	5	2	2	2·2
1902	292	78	26·7	64	21·9	140	44	30·1	14	7	8	10·3
Average of 7 years 1896-1902 inclusive.	343	83	24·3	75	21·9	180	50	28·1	9	2	7	8·7
Average of 7 years 1896-1902 for the County of Durham.†			2·9									
Average of 7 years 1896-1902 for England and Wales.‡			1·93									

* The figures for the construction of this Table were partly supplied by the Medical Officer of Health for the County Council of Durham, and partly by the Medical Officer of Health for the Spennymoor Urban District. They may be taken as approximately correct.

† See Footnote, Table VII.

‡ See Footnote, Table VII.

This table is of interest, as it shows that nearly 90·4 per cent. of the deaths not certified by a registered medical practitioner remain uncertified as the result of unqualified medical practice and that two-thirds of these occur in connexion with children under five years of age. Moreover, it is seen that the proportion of such uncertified children's deaths manifests no tendency to decrease year by year. The table also shows that on an average of seven years inquests were held in only 8·7 per cent. of the uncertified deaths.

The extraordinarily high rate of uncertified deaths in this district has already attracted attention, and it has resulted in correspondence between the County Council of Durham and the Registrar-General's Office. More recently the Registrar-General has written to the Medical Officer of Health ; also the matter has been commented on in the medical press.* These letters are reproduced in Addenda to this Report.

It will be seen from this correspondence that, as a fact, deaths from enteric fever, &c., have not been certified owing to unqualified medical practice. It is obvious that in such cases of infectious disease, since no intimation reaches the Medical Officer of Health until after death, no steps can be taken to prevent the spread of the disease. Moreover, in these cases which are unattended by a registered medical practitioner it is comparatively seldom that the Medical Officer of Health has any information of the infectious sickness at all unless death takes place.

"The Infectious Diseases Notification Act requires that the head "of the family as well as the qualified medical practitioner in "attendance shall notify to the Medical Officer of Health cases of "infectious disease, but when the information is sent by the "medical attendant notification by the head of the family is not "usually insisted upon." (Extract from Report of the County Medical Officer of Health.) An unqualified practitioner is under no obligation to notify cases of infectious disease. It is well known that the notification by the head of the family as well as by the qualified medical practitioner in attendance has never taken practical effect ; for the head of the family rarely notifies the case, and it would seem that in Spennymoor the district council take no steps to enforce this legal obligation on the head of the family where no medical advice has been obtained.

In view of the correspondence between the County Council and the Registrar-General, the further correspondence between the Registrar-General and the Medical Officer of Health for the Spennymoor Urban District, Dr. Anderson, is of some interest. Dr. Anderson, for reasons which he explained to me, and which appeared to me to be sufficient, gave no certificate with reference to the death of a man—Edward Anderson. In consequence the correspondence referred to and reproduced in Addenda to this Report took place.

Dr. Anderson requested the permission of the Registrar-General to forward a copy of the correspondence to the Coroner, and this permission was granted.

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* *British Medical Journal*, 11th April, 1903, page 870—"Uncertified Deaths."

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. Reece.

The Coroner is Mr. J. T. Proud, whose time must be fully occupied, for in addition to being a solicitor in practice of Bishop Auckland, he is also Registrar to the County Court at Bishop Auckland, High Bailiff to the County Court at Bishop Auckland, Registrar to the County Court at Wolsingham, High Bailiff to the County Court at Wolsingham, Clerk to the Urban District Council of Bishop Auckland, Clerk to the Urban District of Shildon, Clerk to the Bishop Auckland Burial Committee, and Clerk to the School Attendance Committee of Shildon.

As a Coroner he is paid by salary, which is £300 per annum.

Summary and Conclusion.

The sanitary condition of Spennymoor Urban District and the administration by the District Council must alike be regarded as unsatisfactory, notably in the following matters:—

(*a.*) The unhealthy conditions in and about dwellings, due to want of paving, draining, and channelling of back-yards or common yards; pollution of soil arising in consquence, and also from large open privy middens, and from the way in which the middens and ash closets are used; the arrangements for dealing with slop water and liquid refuse which often lead to additional fouling, the "back streets" which are badly fouled from the middens and ash closets and from the manner in which these are emptied.

All these are conditions requiring systematic attention by a well-trained and competent Inspector of Nuisances acting under the general instructions of the Medical Officer of Health. Practically the bulk of the time of the Inspector of Nuisances has hitherto been spent in routine supervision of the system of scavenging, which is carried out by a plurality of contractors. No progress is possible while this arrangement holds. It is far from encouraging to know that the District Council, in making a recent appointment to the office of Inspector of Nuisances, chose a man without practical experience of sanitary work and possessing no certificate of competency.

(*b.*) In some parts of the district, notably in the area added in 1894, there is need for sewerage. But the District Council have not provided sewers or have not provided sufficient sewers. In some streets drains intended solely for road washings have been apparently utilized as sewers. In other parts of the district there are sewers, seemingly laid without plan, imperfectly ventilated, defective in construction, without proper means of inspection, and silting up in places.

(*c.*) The District Council has systematically neglected, and has declined when pressed, to take adequate steps to purify sewage At present it discharges sewage in a crude state, or after subsidence only, into the tributaries of the River Wear at a number of points. It adopts a nominal filtration in connection with its Spennymoor Ward system of sewers, but the plant is insufficient for the purpose of efficient treatment of the sewage, and the whole system

is liable to be put out of action at any time by the use of a bypass, as I observed on my visit to the sewage works. In these ways, not only are the brooks traversing the district badly fouled with offensive matter, but serious contamination of the River Wear also takes place.

(*d.*) The District Council's byelaws with respect to new streets and buildings being in many respects out of date, the Council have adopted a new code. Common lodging houses are badly regulated; cowsheds are filthy in many cases; slaughter houses need attention and supervision. All these facts emphasise the need for a competent Inspector of Nuisances and for systematic action by the District Council.

(*e.*) The mortality of this district—infantile, from all causes, from fever, and from diarrhœa—when compared with the corresponding mortality of the County of Durham, or that of England and Wales, is exceptionally high; and this, in my opinion, is largely to be attributed to insanitary conditions which are preventable. It is to be noted that the figures may very well be shown lower than they really are, owing to the custom of accepting uncertified information of death without communication with the Coroner.

The high death-rate from epidemic diarrhœa and allied causes may possibly be due to fœcal pollution of milk and other food supplies through the media of the cowsheds and slaughter houses.

(*f.*) The proceedings of the District Council in erecting an isolation hospital out of borrowed money cannot be regarded as satisfactory from the view point of efficiency. Much trouble had been taken by the Board's officers to advise and assist the District Council in preparing and improving their plans. In constructing the hospital the sanctioned plans were departed from and undertakings were not observed; the result is a hospital in regard of which I cannot consider that the money expended has been employed to the best advantage.

RECOMMENDATIONS.

1. The District Council should seek the advice of a competent engineer with a view to the construction of a complete system of sewers for their district, together with an efficient and comprehensive system of sewage disposal.*

2. The District Council should appoint a competent Inspector of Nuisances possessing the certificate of the Sanitary Institute or some similar body which grants certificates of competency in sanitary knowledge, to act under the direction and with the advice and the assistance of the Medical Officer of Health.

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* While this report is passing through the press I learn that the Local Government Board received on 2nd October an application from the Spennymoor Urban District Council for sanction to a loan of £2,[illegible] for sewage disposal works. The works in question appear to have relation to the Spennymoor Ward alone.

3. The Inspector of Nuisances should be relieved of the supervision of the scavenging of the district, with a view to enable him to devote more time to the duties appertaining to his office under the Local Government Order of March 23, 1891.

4. All midden-privies which cause nuisance should be replaced by closets of suitable kinds, constructed on the lines prescribed in the Local Government Board's model byelaws.

5. The byelaws as to common lodging houses should be enforced, preferably by the Inspector of Nuisances and not by a police constable.

6. Systematic attention should be directed to the proper scavenging of back streets with a view to promote their greater cleanliness.

7. The District Council should cause all dwellings which from dampness, want of ventilation, dilapidation, and other structural defects are unfit for habitation to be placed in proper repair; or should take action with a view of getting such dwellings permanently closed.

8. Nuisances should be systematically and promptly dealt with on the lines laid down on page 85 of this Report.

9. The District Council should enforce the Regulations for Dairies, Cowsheds, and Milkshops in their District.

ADDENDA.

No. 1

CORRESPONDENCE BETWEEN THE REGISTRAR-GENERAL OF THE DURHAM COUNTY COUNCIL AS TO UNCERTIFIED DEATHS IN THE SPENNYMOOR URBAN DISTRICT.

No. 2.

CORRESPONDENCE BETWEEN THE REGISTRAR-GENERAL AND DR. ANDERSON CONCERNING THE NON-CERTIFICATION OF DEATHS IN THE SPENNYMOOR URBAN DISTRICT.

No. 3.

EXTRACTS FROM THE COUNTY MEDICAL OFFICER'S QUARTERLY REPORTS, TOGETHER WITH COPIES OF CORRESPONDENCE BETWEEN THE LOCAL GOVERNMENT BOARD, COUNTY COUNCIL, AND THE SPENNYMOOR URBAN DISTRICT COUNCIL IN REFERENCE TO THE CONDITION OF THE URBAN DISTRICT.

ADDENDUM No. 1.

CORRESPONDENCE BETWEEN THE REGISTRAR-GENERAL AND THE COUNTY COUNCIL OF DURHAM AS TO UNCERTIFIED DEATHS IN THE SPENNYMOOR URBAN DISTRICT.

Shire Hall, Durham,
26th July, 1900.

SIR,

I AM directed by the County Council of Durham to transmit to you the enclosed print of paragraphs 16 and 17 of the County Medical Officer's Report for the quarter ending 30th ultimo, and to invite your attention to the subject.

Yours faithfully,
RALPH SIMEY,
Clerk of the County Council.

The Registrar-General,
Births, Deaths, and Marriages.

COUNTY MEDICAL OFFICER'S REPORT.

6th July, 1900.

UNCERTIFIED DEATHS.

15. During the last few years there has been a very marked decline in the county in the number of uncertified deaths, owing almost entirely to discontinuance of medical practice by unqualified persons.

16. In the urban district of Spennymoor, however, the number of deaths last year which were uncertified as a result of such practice was 77, or nearly 20 per cent. of the total deaths, and during the first half of this year these deaths numbered 39, or 25·5 per cent. of the total deaths. During the past quarter there have been two deaths from enteric fever and one from scarlet fever which were

APP. A, No. 5.

Sanitary condition and administration of the Spennymoor Urban District; by Dr. Reece.

uncertified owing to the attendance of an unqualified practitioner, and in none of these infectious cases was any intimation given to the Medical Officer of Health of their existence, and, consequently, no precautions could be taken to prevent the spread of the disease. The matter was reported to the Urban District Council, but I am not aware that any action has been taken by them to prevent such unqualified practice. The non-notification of cases of infectious disease is an undoubted danger to the public health, and the risk to the individual, owing to medical attendance by an unskilled and unqualified practitioner, is undoubtedly very serious.

17. The Infectious Diseases Notification Act requires that the head of the family, as well as the qualified practitioner in attendance, shall notify to the Medical Officer of Health cases of infectious disease, but when the information is sent by the medical attendant notification by the head of the family is not usually insisted upon. When, however, the services of an unqualified practitioner, who is under no obligation to notify cases of infectious disease, are engaged, the head of the family ought to be obliged to notify as required by the Act, and it is the duty of the Urban District Council to enforce the provisions of the Act in this respect. I should also suggest that the attention of the General Medical Council, the Registrar-General, and the Society of Apothecaries, London, be called to the extent of, and the circumstances connected with, unqualified practice in Spennymoor.

T. EUSTACE HILL,
County Medical Officer.

General Register Office,
Somerset House, London, W.C.,
30th July, 1900.

SIR,

I AM directed by the Registrar-General to acknowledge the receipt of your letter of the 26th instant, and of the accompanying extract from the Medical Officer's Report for the quarter ending on the 30th ultimo. I am, in reply, to inform you that the Registrar-General is fully sensible of the evils arising from the large proportion of uncertified causes of death in many parts of the County of Durham, but that he has no power to initiate the necessary legislation for its suppression. I am to point out that under the present state of the law it appears to the Registrar-General that the only way to decrease the proportion of uncertified deaths is to prevail upon the Coroners to hold inquests upon some of the uncertified deaths in those localities in which the largest proportions of such deaths are recorded.

Your obedient Servant,

NOEL A. HUMPHREYS,
Chief Clerk.

Clerk to County Council,
Durham.

Shire Hall, Durham,
8th November, 1900.

SIR,

IN further answer to your letter of 30th July last, relative to the large proportion of uncertified cases of death in many parts of this county, I am directed by the County Health Committee to send you the enclosed copy of a letter from Mr. J. T. Proud, one of the County Coroners, and to inform you that it is the opinion of this Committee that the District Registrars of Births and Deaths should be instructed to report to the Coroners all cases of death which are not certified by a qualified medical practitioner, so that the Coroners may exercise their own discretion as to whether an inquest should be held or not, and I shall be obliged if you will inform me at your early convenience whether or not you consider it within your province to issue instructions to that effect.

Yours faithfully,

RALPH SIMEY,
Clerk of the County Council

The Registrar-General.

Sanitary condition a administra of the Spe moor Urba District; b Dr. Reece.

Bishop Auckland,
12th September, 1900.

Uncertified Deaths.

DEAR DR. HILL,

I QUITE agree with you that the Registrar-General ought to ask the District Registrars not to register deaths at all when certified by unqualified practitioners, as, if they do, the cases never come to the notice of the Coroner at all.

In many cases now when the qualified medical man has not seen the person before death he states the fact in his certificate, or instead of giving a certificate sends a note to the Registrar. These cases invariably go on to the Coroner, who in turn instructs the police to make local enquiries, and if they are satisfactory and there are no suspicious circumstances the Coroner gives a certificate without holding an inquest.

I think the same course ought to be adopted by the District Registrars in all cases when certificates are sent by unqualified Practitioners, as I believe they are much less particular than the ordinary Doctor and certify in many cases when they have not seen the person before death.

By this means they gain favour among the more ignorant, as many a drunken mother who habitually neglects her children would rather have them attended by a good certifier than a good Doctor.

Yours truly,

J. T. PROUD.

General Register Office,
Somerset House, London, W.C.,
14th November, 1900.

SIR,

I AM directed by the Registrar-General to acknowledge the receipt of your letter of the 8th instant, and, in reply, to state for the information of the County Health Committee, that of the 622 Uncertified Causes of Death, in the County of Durham during 1899, no fewer than 419 were referred to the Coroners without the result of an Inquest being held; whereas, it is presumed that the object Mr. J. T. Proud has in view in desiring that Registrars should be instructed to report to Coroners *all* Deaths, the causes of which are not certified by a Registered Medical Practitioner, is to facilitate the holding of Inquests in such cases.

I am therefore to point out, that while the Registrar-General is willing to promote any measure that would reduce the proportion of uncertified causes of death, he hesitates to adopt measures for increasing the number of such deaths reported to Coroners, unless he were assured that the proposed measure, which would necessarily cause delay in registration, would have probably the desired effect.

I am to request that the Registrar-General may be informed as to the precise boundaries of the areas forming the Districts of the four Coroners acting within the County of Durham.

Your obedient Servant,

NOEL A. HUMPHREYS
Chief Clerk.

Clerk to County Council,
Durham.

Shire Hall, Durham,
27th November, 1900.

SIR,

IN further answer to your letter of 14th instant I am directed by the County Council of Durham to suggest that the 622 uncertified cases of death there referred to probably include that class of cases in the whole registration County of Durham which comprises the County Boroughs of Gateshead, South Shields, and Sunderland, over which the County Council has no jurisdiction in health matters.

PP. A, No. 5.

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The County Medical Officer has reported that in the administrative County there were only 373 uncertified cases of death in 1899, and that of that number 117 were uncertified in consequence of having been attended by Unregistered Medical Practitioners.

I am also to point out that of these 117 cases no less than 77 occurred in the Urban District of Spennymoor, and that under present circumstances it is not deemed necessary that any steps should be taken with respect to the other 40; and I am to ask you to be good enough to instruct the District Registrars in Spennymoor to report to Mr. Coroner Proud all deaths in that Urban District the causes of which are not certified by a Registered Medical Practitioner.

I enclose as you request a List, prepared by the Home Office in 1895, of Coroners' Jurisdictions in England and Wales, showing at pages 12 and 13 the Districts of the four Coroners of this County.

Yours faithfully,

RALPH SIMEY,

Clerk of the County Council.

The Registrar-General.

General Register Office,
Somerset House, London, W.C.,
1st December, 1900.

SIR,

I AM directed by the Registrar-General to acknowledge the receipt of your letter of the 27th ultimo, and in reply to state for the information of the Durham County Council, that in deference to their request he has this day instructed the Registrars of Births and Deaths for the three Sub-Districts, within which the Urban District of Spennymoor is situated, to report to the Coroner, previous to their registration, all deaths the causes of which are not duly certified by a Registered Medical Practitioner. I am to express the Registrar-General's hope that this course will result in the reduction of the excessive proportion of uncertified deaths in this district.

I am to request that in order to avoid public inconvenience through delay of registration and burial, measures may be adopted to have the decision of the Coroner, in cases in which he decides *not* to hold an Inquest, communicated to the Registrars as promptly as possible.

I am to thank you for having forwarded to the Registrar-General the Home Office List showing the Jurisdictions of Coroners in England and Wales in 1895, which will be useful for Census purposes.

Your obedient Servant,

NOEL A. HUMPHREYS,

Chief Clerk.

Clerk to County Council,
Durham.

Shire Hall, Durham,
3rd December, 1900.

Uncertified Deaths.

SIR,

I HAVE to acknowledge the receipt of your letter of 1st instant, and to say that the subject to which it relates shall receive due attention.

Yours faithfully,

RALPH SIMEY.

The Registrar-General.

General Register Office,
Somerset House, London, W.C.,
13th February, 1901.

Auckland, &c.

SIR,

I BEG to refer to my letter to you of December 1st last, intimating that instructions were given by me on the same day to the Registrars of Births and Deaths acting within the Spennymoor Urban District that they were exceptionally to report *all* deaths not certified by a Registered Medical Practitioner to the Coroner prior to Registration.

The delay thus occasioned in Registration has naturally caused inconvenience, and, after communicating with the Coroner, I do not find that the instruction has had any commensurate effect.

I am therefore to-day writing to the Registrars to suspend this special instruction, intimating, however, to them that they should in the exercise of their ordinary discretion use exceptional care in dealing with cases in which the Certificate of a Registered Medical Practitioner is not forthcoming, and that they should report to the Coroner all cases in which there seems to be any suspicion of neglect, or ground for doubt or enquiry.

Your obedient Servant,
REGINALD MACLEOD,
Registrar-General.

Ralph Simey, Esq.,
Clerk, County Council.

Shire Hall, Durham,
14th February, 1901.

Auckland, &c.

SIR,

I BEG to acknowledge the receipt of your letter of yesterday adverting to the special instructions you had previously given to the Spennymoor Registrars to Report to the Coroner, prior to registration, all deaths not certified by a Registered Medical Practitioner, and stating that the "delay thus occasioned in registration" had "naturally caused inconvenience, in consequence of which you had written to the Registrars suspending the special instructions.

On receipt of your letter I telegraphed you at once, asking that the suspension might be withheld until enquiries can be made into the supposed delay. In the meantime, on behalf of the County Council, I have to state that no such delay has come to their notice, but that the subject shall be at once fully enquired into and the result communicated to you, and I am to ask you to be good enough to place at the disposal of the County Council the information on which the suspension order was made.

And I am also to express the surprise of the County Council that an instruction given to the Registrars at their instance and only after considerable correspondence should have been withdrawn, without any previous intimation to the County Council, or any of their officers.

Yours faithfully,
RALPH SIMEY,
Clerk of the County Council.

The Registrar-General.

General Register Office.
Somerset House, London, W.C.,
15th February, 1901.

SIR,

I BEG to acknowledge the receipt of your letter of the 14th instant, and in reply to say that having already intimated my decision it was impossible to delay instructions to the Registrars in the Spennymoor District on receipt of your telegram.

APP. A, No. 5.

Sanitary Condition and Administration of the Spennymoor Urban District; by Dr. Reece.

I may remind you that the Regulations which govern the action of the Registrars are issued under the authority of the Registrar-General as confirmed by the President of the Local Government Board, and these Regulations contain no instruction that *all* deaths not certified by a Registered Medical Practitioner are to be reported by the Registrar to the Coroner.

On representations made by your Council and by the Coroner I deemed it desirable, as a temporary expedient, to desire that all such deaths should be reported; but finding, after the lapse of a considerable time and after correspondence with the Coroner and the Registrars, that the only effect of my action had been to cause the delay in registration, which is the inevitable result of a reference to the Coroner, I deemed it right to revert to the ordinary practice.

Your obedient Servant,

REGINALD MACLEOD,

Registrar-General.

Ralph Simey, Esq.,
Clerk of the County Council.

Shire Hall, Durham,
22nd February, 1901.

Auckland.

SIR,

I BEG to acknowledge the receipt of your letter of 15th instant, and to inform you that enquiry having been made into the circumstances, there does not appear to be any adequate reason for the suspension of your directions to the District Registrars in the Spennymoor Urban District to report all uncertified deaths to the Coroner.

The chief ground stated for the suspension is the supposed delay in registration caused by your directions; but the time between the death and registration, in the case of the uncertified deaths which have been referred to the Coroner (at any rate in the St. Oswald's Sub-Registration District), has not exceeded the five days allowed by law for registration by the friends or relatives in cases of properly certified deaths. Any inconvenience caused by delay is, in nine cases out of ten, only felt by persons who for various reasons (one of which is probably that mentioned by Coroner Proud in the last paragraph of his letter of 12th September, 1900) call in as medical attendant a man who not only possesses no legal qualification, but has never had any proper medical training. Such a practice not only seriously impairs the value and accuracy of vital statistics, but is also fraught with serious danger to the public health, and persons who with open eyes persist in encouraging it have no just cause of complaint if they are put to some inconvenience.

I have also to point out that it is not quite correct to say that the only effect of the (now suspended) directions has been delay in registration, for although inquests may not have been held (and it is to be regretted that the Coroner has not as yet thought it necessary to hold any inquests into the cases specially reported to him) an enquiry is made by the police into cases so reported, and the mere knowledge of the fact that such enquiry will be made by the police tends to prevent criminal action on the part of parents who might have an interest in the death of their children.

The local outcry which has been made by certain persons is undoubtedly not on account of delay in registration, but because the inquiry by the police is objected to.

During the year 1900 there were 79* uncertified deaths in the Spennymoor Urban District, and of these 69 (or 21 per cent. of the total deaths) were uncertified the result of attendance during life of an unqualified practitioner. Moreover of these 69 deaths 38 (or more than 55 per cent.) were under five years of age.

As stated by the General Medical Council in their letter of the 28th November last, the County Council is of opinion that such a state of matters "is one of grave

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* See Tables VII. and IX. and footnotes thereto.

concern to the public health, and calls for the stringent enforcement of the existing law." It is much to be regretted that the Registrar-General should, without any urgent reason, suspend his directions to the District Registrars to report all uncertified deaths to the Coroner, and by so doing practically countenance its continuance; and I am therefore to ask that the suspension may be withdrawn.

Yours faithfully,

RALPH SIMEY,

Clerk of the County Council.

The Registrar-General.

General Register Office,
Somerset House, London, W.C.,
26th February, 1901.

SIR,

I AM directed by the Registrar-General to acknowledge the receipt of your letter of the 22nd instant, and in reply to inform you that, under present circumstances, he sees no reason for re-issuing any exceptional instructions to the Registrars of Births and Deaths acting within Spennymoor Urban District.

Your obedient Servant,

NOEL A. HUMPHREYS,

Chief Clerk.

Ralph Simey, Esq.,
Clerk to County Council.

ADDENDUM NO. 2.

CORRESPONDENCE BETWEEN THE REGISTRAR-GENERAL AND DR. ANDERSON CONCERNING THE NON-CERTIFICATION OF DEATHS IN THE SPENNYMOOR URBAN DISTRICT.

1

General Register Office,
Somerset House, London, W.C.,
25th November, 1902.

Auckland,
13,916. R. 1902.

SIR,

I AM directed by the Registrar-General, with reference to the death of Edward Anderson, aged 61, at 41, Coltman Yard, Merrington Lane, on 2nd September last, who is stated to have been attended by you in his last illness, to request that you will inform the Registrar-General whether you issued a medical certificate of the cause of death on one of the official forms in this case, as the Coroner appears to have considered an Inquest unnecessary, and the cause of death was irregularly entered in column 6 of the death entry as "natural causes."

I am, Sir,

Your obedient Servant,

NOEL A. HUMPHREYS,

Chief Clerk.

R. S. Anderson, Esq., M.D.,
Hillingdon House,
Spennymoor,
Durham.

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[*Reply.*]

Spennymoor,
26th November, 1902.

Auckland,
13,916. R. 1902.

SIR,

IN reply to your enquiry of yesterday, I did not give any certificate of the cause of death on the official form or otherwise in this case to the Registrar. I may add that, in this district, it appears to matter little whether there is a certificate from a medical man or not, as burial certificates are granted and insurance monies paid whether deaths are certified or uncertified, and men can do with impunity that which elsewhere is followed by enforced retirement from public life for a prolonged period.

I am,

Your obedient Servant,

ROBT. S. ANDERSON.

The Registrar-General,
Somerset House.

2.

General Register Office,
Somerset House, London, W.C.,
1st December, 1902.

Auckland,
14,070. R. 1902.

SIR,

I AM directed by the Registrar-General to acknowledge the receipt of your letter of the 26th ultimo, and in reply to inform you that as the case of Edward Anderson was referred to the Coroner, and as the Coroner declined to hold an Inquest, the local Registrar had no option but to register the death, as it is presumed that you did not feel yourself justified in certifying the cause of death in this case, and that you were not in attendance on the deceased man during his last illness. The Registrar-General will be further obliged by you informing him whether you reported the case to the Coroner, and whether you furnished to him any written statement of the cause of death.

I am, Sir,

Your obedient Servant,

NOEL A. HUMPHREYS,

Chief Clerk.

R. S. Anderson, Esq., M.D.

[*Reply.*]

Spennymoor,
2nd December, 1902.

Auckland,
14,070. R. 1902.

SIR,

I BEG to acknowledge receipt of your letter of yesterday, and in reply have to state that I did attend the deceased in his last illness, and directed his son who applied for certificate of cause of death, to acquaint the police of the death so that they might inform the Coroner. I did not supply the Coroner with any statement, nor was I asked to do so. An official from the Miners' Permanent Fund office in Newcastle came to me for information in regard to the case, as he also did in the case of a man named Conolly, whose death had been registered (a few weeks before Anderson's) as due to "Natural causes, certified by Coroner." Apart from this case altogether, I think that the registration of

deaths in this district is most unsatisfactory and pretty much of a farce, and if carried out in the same way throughout the country would render your statistical returns of little value. In the returns supplied to me by the local Registrars of the deaths which occurred in this Urban District during November last, I find there are 8 uncertified owing to unqualified medical practice, and 3 uncertified registered as the Coroner's certificates—11 out of a total of 38, or nearly 30 per cent. I think you will agree that this points to a most scandalous state of affairs, and that some remedy ought to be found. I would also point out that on the 16th of October last an uncertified death was registered from "membranous croup," and on the 22nd November one from "diphtheria." Both of these were notified to me by an unqualified man, and death occurred in both cases before the notification reached me.

I am,

Your obedient Servant,

ROBT. S. ANDERSON, M.D.,

Medical Officer of Health, Urban District.

The Registrar-General,
Somerset House.

3.

General Register Office,
Somerset House, London, W.C.,
8th December, 1902.

Auckland.
14,343. R. 1902.

SIR,

I AM directed by the Registrar-General to acknowledge the receipt of your letter of the 2nd instant, and to thank you for the information it contains I am, in reply, to inform you that he deplores the large proportion of uncertified causes of death in Spennymoor, but holds the opinion that in the present state of the law no remedy is possible unless the Coroner, in the exercise of his statutory discretion, were to hold inquests in such cases as the one dealt with in the recent correspondence, and in those to which you call attention in your letter referred to above.

I am, Sir,

Your obedient Servant,

NOEL A HUMPHREYS,

Chief Clerk.

Robert S. Anderson, Esq., M.D.,
Medical Officer of Health,
Spennymoor.

[*Reply.*]

Spennymoor,
13th December, 1902.

Auckland.
14,343. R. 1902.

SIR,

I HAVE to thank you for your letter of the 8th inst., and shall be glad to know whether you have any objection to my forwarding a copy of the correspondence to the Coroner.

I am,

Your obedient Servant,

ROBT. S. ANDERSON.

The Registrar-General,
Somerset House.

APP. A, No. 5.

Sanitary condition and administration of the Spennymoor Urban District; by Dr. Reece.

4.

General Register Office,
Somerset House, London, W.C.,
15th December, 1902.

Auckland.
14,779. R. 1902.

SIR,

I AM directed by the Registrar-General to acknowledge the receipt of your letter of the 13th instant, and, in reply, to inform you that he will raise no objection to your forwarding to the Coroner a copy of the letters recently addressed to you on the subject of the death of the recently deceased man Anderson.

I am, Sir,

Your obedient Servant,

NOEL A. HUMPHREYS,

Chief Clerk.

R. S. Anderson, Esq., M.D.
Spennymoor,
Durham.

ADDENDUM No. 3.

[*Memorandum on Spennymoor Urban District prepared by the Durham County Council.*]

EXTRACTS FROM THE COUNTY MEDICAL OFFICER'S QUARTERLY REPORTS, TOGETHER WITH COPIES OF CORRESPONDENCE BETWEEN THE LOCAL GOVERNMENT BOARD, COUNTY COUNCILS, AND THE SPENNYMOOR URBAN DISTRICT COUNCIL, IN REFERENCE TO THE CONDITION OF THE URBAN DISTRICT.

EXTRACT FROM COUNTY MEDICAL OFFICER'S REPORT FOR QUARTER ENDING 30TH SEPTEMBER, 1901.

"Although during the past few years considerable improvements have been effected in this district, especially as regards sewerage, making of streets and paving of footpaths, the sanitary circumstances of a large proportion of the houses in this district are extremely bad, owing to want of paving of back streets, damp and defective yards, and foul, insanitary midden-privies. I recently inspected the greater portion of this district, and in almost every street I found very serious nuisances resulting from the above-mentioned defects. I regret to state that even where the attention of Urban District Council has been drawn in my past reports to most unhealthy conditions, such as the midden-privies in Edward Street, Craddock Street, George Street, and Jackson Street, no action has been taken. In George Street and several of the older streets the houses only consist of one room and a small unventilated attic, but the Urban District Council are taking action, under the Housing of the Working Classes Act, respecting a number of these houses and also several insanitary dwellings in Thomas Street.

"In his last annual report the district Medical Officer of Health drew attention to the insanitary conditions of the conveniences at several of the elementary schools; at the Wesleyan schools, Mount Pleasant, the National schools, Mount Pleasant, and in the girls' department of the Wesleyan schools, Tudhoe Grange, they consist of offensive and insanitary midden-privies, the use of which, by the children, must be a serious danger to their health. Automatically flushed trough closets ought to be substituted for the present objectionable structures.

"Except that the scavenging and removal of refuse appears to be well performed, I was unable to note any substantial improvement in the sanitary condition of this district since my last inspection in September of last year.

"In his annual report of 1899 the Medical Officer of Health drew attention to the excessive infant and zymotic death-rates and especially to the prevalence of enteric fever and the large mortality from diarrhœa, which he attributed to insanitary conditions and particularly the many foul midden privies. During the past quarter there has been an enormous mortality in the district, the total death rate of the whole quarter being equal to a rate of 37·6 per 1,000, the zymotic rate 16·5 per 1,000, and the infant mortality rate 426 per 1,000 births. In the month of August the figures were even worse, the death-rate exceeding 60 per 1,000, the zymotic rate 31 per 1,000, and the infant mortality 508 per 1,000. I have no hesitation in saying that a considerable proportion of the deaths occurring during the past quarter have directly resulted from gross insanitary defects which the Urban District Council ought systematically to have dealt with years ago."

LETTER FROM URBAN DISTRICT COUNCIL TO COUNTY COUNCIL.

Spennymoor,
5th December, 1901.

Medical Officer's Report.

DEAR SIR,

REFERRING to your letter of the 11th ulto., enclosing copy of the County Medical Officer's Report for the quarter ending 30th September last, I am directed to state :—"That this Council is far from denying that insanitary property is to be found in the District; this unfortunately is a condition common to all Districts, though the same attention is not drawn to it. The Council assure you that an examination of the reports of their Sanitary Inspector, and the Council's action based thereon, would prove that much is being done, and great pressure being applied to remedy existing defects, and to provide better sanitary arrangements. The Council protest in the strongest manner possible to them against the language of wholesale and exaggerated condemnation employed by the County Medical Officer and assure you that if similar evils are not reported in other districts it is not because they do not exist, but rather because the same attention is not given to them"

Yours faithfully,
F. BADCOCK.

Ralph Simey, Esq.,
Clerk of the County Council,
Durham.

December 19th, 1901.

Copies of Sanitary Inspector's Reports for previous six months forwarded to County Council.

LETTER FROM LOCAL GOVERNMENT BOARD TO URBAN DISTRICT COUNCIL.

Local Government Board,
Whitehall, S.W.,
15th January, 1902.

SIR,

I AM directed by the Local Government Board to forward to the Spennymoor Urban District Council the enclosed copy of a communication which the Board have received from the Durham County Council with reference to the sanitary condition of the Urban District, and I am to request that the Board may be furnished with the observations of the District Council on the subject.

I am, Sir,
Your obedient Servant,
JOHN LITHIBY,
Assistant Secretary.

The Clerk to the Urban District Council,
Spennymoor.

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Shire Hall,
Durham,
25th November, 1902.

SIR,

I AM directed by the County Council of Durham to transmit to you the enclosed Representation to the Local Government Board, under Section 299 of the Public Health Act, 1875, as to the general and continued insanitary condition of the Spennymoor Urban District. I also send you copies of the Reports of the County Medical Officer and District Medical Officer, and of a correspondence between the County Council and the Urban District Council since 30th January, 1900, to the present time, relative to the default of the District Council to provide their district with sufficient sewers and otherwise to enforce the provisions of Sections 15, 27, 36, 92 to 111, and 150 of the Public Health Act, 1875.

I am, Sir,

Yours faithfully,

(Signed) RALPH SIMEY,
Clerk of the County Council.

The Secretary,
Local Government Board.

COUNTY OF DURHAM.

SPENNYMOOR URBAN DISTRICT.

Representation to the Local Government Board under Section 299 of the Public Health Act, 1875, as to the general and continued insanitary condition of the district.

Throughout the district most serious nuisances exist owing to proximity of open insanitary midden-privies to dwellings, to unpaved back streets, and to damp and defective house yards.

The death-rate, zymotic death-rate, and infant mortality rate, are all considerably above the average of the urban districts in the county, and during the past summer have been exceptionally excessive. In the opinion of the County Council the cause for these high rates is the grossly insanitary circumstances which, as revealed by the reports of the District Medical Officer of Health and County Medical Officer, prevail in the district.

Attached are the chief mortality statistics of the Spennymoor Urban District and the Urban Districts of the County during the years 1896–1900, and during the first nine months of this year, together with extracts from the reports of the County and District Medical Officers of Health :—

	Per 1,000 population.		Per 1,000 births registered.
	Total death-rate.	Zymotic death-rate.	Infant mortality rate.
Average of 5 years, 1896–1900 :—			
Spennymoor Urban District	19·0	2·8	191
*Urban Districts in Administrative County	18·2	2·1	166
Average, 1st January to 30th September, 1901 :—			
Spennymoor Urban District	28·0	6·7	250
*Urban Districts in Administrative County	19·6	3·2	182

* Including Spennymoor.

Sanitary condition and administratio of the Spenny moor Urban District; by Dr. Reece.

COUNTY HEALTH COMMITTEE'S MINUTES.

24th October, 1900.

Resolved :—

That the County Medical Officer do prepare and present to next meeting a Representation to be made to the Local Government Board as to the insanitary condition generally of the Spennymoor Urban District.

LETTER FROM URBAN DISTRICT COUNCIL TO LOCAL GOVERNMENT BOARD.

Spennymoor,
27th February, 1902.

SIR,

IN reply to your letter of the 15th ult., I am directed by the Council to state that in reference to the representation of the Durham County Council they do not admit all the facts stated by the County Council.

This Council has, since the 31st December, 1894, the time when the boundaries of the Spennymoor Local Board were extended, been actively engaged in dealing with the insanitary condition of the district.

(1) During the last seven years the Council have made up no less than 92 private streets and have taken them over.

(2) As to the sewerage in Spennymoor Ward, the Council consider this fairly good; and in Tudhoe and Ferryhill Wards they have recently had considerable portions of the sewers relaid, and upon any report of defective sewers have had them immediately repaired.

(3) The sewage disposal works for Spennymoor Ward are being remodelled, and when complete will be quite capable of dealing with the sewage of that Ward.

For Tudhoe and Ferryhill Wards, plans, &c., for sewage works have been under consideration for some time, but on account of the Council having changed their surveyors three times during the last 18 months, and the difficulty in obtaining the necessary land, some delay has been caused, but the matter is receiving the Council's serious attention.

(4) As shown by the Medical Officer's yearly reports, it will be seen that during the last two years there have been 145 earth-closets substituted for ashpits; 23 notices served, dealing with 57 houses, under the Housing of the Working Classes Act; and, on an average, 1,220 notices a year served by the Inspector of Nuisances under the Public Health Act.

(5) As to the zymotic death-rate in the Spennymoor District, it will be seen by the County Returns that the average for the year 1901, with the exception of the third quarter, is only 2, as against 3·2 for the county.

For the quarter ending 30th September last there was an unusual prevalence of diarrhœa and measles amongst the children, which accounted almost for the whole of the zymotic death-rate in that quarter.

(6) It may be pointed out that the infant mortality for the Administrative County for the last quarter was 163, and for Spennymoor District only 157.

(7) As to the death-rate :—The death-rate for the Urban District for 1901 is 25, which, as stated above, includes the unusual death-rate caused by diarrhœa and measles, which rate is considerably less than the three quarters quoted by the County Council in their representation.

The Council is erecting an Isolation Hospital, which is expected to be complete by Midsummer, thus providing accommodation for certain Infectious Diseases,

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(8) From the foregoing figures, &c., it will be seen that this Council is endeavouring to do its duty, as far as lies in its power, and have been carrying out all the works as provided by Sections 15, 27, 36, 92 to 111 and 150 of the Public Health Act, 1875, and while not shirking an enquiry, think there is no need for your Honourable Board to hold an enquiry, despite what may be the opinion of the County Council in its wholesale condemnation.

I am, Sir,

Your obedient Servant,

F. BADCOCK,

Clerk.

The Secretary,
Local Government Board,
Whitehall, S.W.

EXTRACT FROM COUNTY MEDICAL OFFICER'S REPORT FOR QUARTER ENDING 31ST DECEMBER, 1901.

"At the request of the District Council, I recently supported them with my evidence in proceedings before the Magistrates respecting some insanitary property in this district, and an order was made for the remedying of the defects.

"Letters from the District Council with reference to the observations on the sanitary condition of this district, contained in my last quarterly report, together with reports of the district Sanitary Inspector of the District Council from June to November last, have been forwarded to the County Council and will be laid before you. The Inspector's reports indicate that he is doing excellent work in detecting insanitary conditions in the district and reporting them to the District Council, but the number and serious nature of the defects mentioned in his reports strongly support the statement made in my quarterly reports as to the insanitary condition of many parts of the district, and which the District Council protests as 'the language of wholesale and exaggerated condemnation.'"

LETTER FROM URBAN DISTRICT COUNCIL TO COUNTY COUNCIL.

Spennymoor,
28th February, 1902.

County Medical Officer's Report.

DEAR SIR,

Your letter of the 3rd inst., together with copy of County Medical Officer's Report for the quarter ending 31st December last, was brought before the Council at their meeting yesterday, and I was directed to acknowledge receipt of same.

Yours faithfully,

F. BADCOCK.

Ralph Sumer, Esq.,
Shire Hall,
Durham.

Sanitary condition a administra of the Spen moor Urba District ; b Dr. Reece.

Extract from County Medical Officer's Report for Quarter ending 30th June, 1902.

"As directed by your Committee, I beg to report as follows on the statements contained in the letter of the Urban District Council dated 27th February last, a copy of which was enclosed by the Local Government Board with their letter to the County Council of 15th April last :—

101. 1 & 2.—I have no reason to doubt the accuracy of the statements as to the making and taking over by the District Council of 92 private streets, and to the improvements in the sewers of the district during the past seven years: and I would point out that in my report for the quarter ending 30th September, 1901, I stated that 'considerable improvements have been effected in this district, especially as regards sewerage, making of streets, and paving of footpaths.'

3.—The disposal of the sewage of the district is very unsatisfactory. The disposal works for the Spennymoor Ward, although they have been improved, are too small to deal with more than a portion of the sewage, and a large volume of it constantly passes into the stream near the works, close to a public footpath.

There are no sewage disposal works for the Spennymoor and Ferryhill wards, and the whole of the sewage passes unpurified into streams, causing a nuisance and gross pollution. The District Council state that some delay has occurred in this matter, owing to their having changed their surveyor three times during the last eighteen months, and to the difficulty in obtaining necessary land, but I would point out that 12 years have elapsed since the County Council first urged the Urban District Council to prevent the pollutions arising from the want of purification of the sewage of these populous districts.

4.—The statements that 145 ash-closets have been substituted for ashpits, and 23 notices relating to 57 houses served under the Housing of the Working Classes Act during the last two years, and that 1,220 notices have been served on an average annually under the Public Health Acts, are no doubt correct, but it is also a fact that in the enforcement of the notices served there has very frequently been great and unnecessary delay.

5 & 6.—The mortality statistics quoted in the letters of the Urban District Council and the comparisons drawn are misleading, as they omit the statistics for the third quarter of the year, when an excessive mortality from infantile diarrhœa, which is recognised as a filth disease caused by insanitary dwellings and surroundings, occurred.

The representation of the County Council to the Local Government Board showed that during the five years 1896-1900 the total death-rate, zymotic death-rate, and infant mortality rate for Spennymoor considerably exceeds those for the urban districts in the County, and the following table shows how unfavourably the chief mortality statistics in Spennymoor compare with those for the urban districts and the County during 1901 :—

—	Total death-rate.	Zymotic death-rate.	Infant death-rate per 1,000 births.
Spennymoor	24·9	5·6	231
Urban Districts	19·4	3·0	178
Administrative County	19·0	2·9	177

7.—The death-rate and zymotic death-rate in the Spennymoor Urban District last year were the highest of any district in the county, and I have no hesitation in stating that they were largely the result of the insanitary conditions prevailing in so many parts of the district.

8.—The statement as to the erection of an isolation hospital is correct, but in their representation to the Local Government Board the County Council made no complaint as to the default of the District Council in this matter.

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During the past quarter I have again inspected the greater part of this district and I regret to say the remarks made in my previous reports as to its insanitary state still apply. Throughout the district there are badly constructed ashpit-privies, sometimes very close to dwellings, which foul the air and soil, the pollution of the latter being facilitated by the want of paving of the back streets and the defective paving of many of the house yards.

In some streets ash closets have been substituted for the old conveniences, but even in properties dealt with by notice under the Public Health Acts the defects are often only partially remedied, and the sanitary circumstances remained unsatisfactory. The nuisances from unpaved streets defective yards and insanitary middens are very general throughout the district, but in Dundas Street, George Street, Jackson Street, Princess Street, Rosa Street, and in Merrington Lane and Low Spennymoor, the defects are perhaps most noticeable.

No action appears to have been taken to remove the nuisances arising from the grossly insanitary conveniences in use at the Elementary Schools at Tudhoe Grange and Mount Pleasant, although the attention of the Urban District Council was drawn to them by the Medical Officer of Health in his annual report for 1900, and by my report for the quarter ending September last.

In Low Spennymoor and Merrington Lane there are a number of back-to-back houses, and in Spennymoor, especially in the Carnes Street and George Street districts, there are a great many houses which contain only one living room and a small objectionable attic, but I was informed by the Inspector that notices have already been served on the owners under the Housing of the Working Classes Act, and that they will be enforced unless the houses are made properly habitable.

In his last annual report the district Medical Officer of Health gives his opinion that soil pollution, resulting from the midden-privies and defective house yards, was the chief cause of the high zymotic death rate, and until the Urban District Council systematically compel the owners of private property to remedy the gross defects that at present exist, it is quite certain that the mortality statistics of the district, especially from zymotic diseases and among children, will remain high.

In my opinion much good would result from a complete inspection of the district by one of the Medical Inspectors of the Local Government Board, and it is to be hoped that the Board will reconsider their decision, expressed in their letter to the County Council of 15th January last, that section 299 of the Public Health Act, 1875 is not applicable to a case of default by a sanitary authority in the enforcement of the provision of improved privy accommodation, and of the provisions of the Act relating to nuisances.

The attention of the District Council should be drawn to the insanitary conditions existing at some tenement dwellings in Jackson Street. These houses have only been erected within the last two or three years, but the common yard has not been properly levelled, and is unpaved and filthy. The houses are provided with indoor waterclosets, but the only ashpit accommodation is an offensive wooden structure in the yard, placed against one of the house walls, and neither in its position nor structure does it comply with the bye-laws in force in the district. Apparently the bye-laws do not require the paving or cementing of the back yards, but in tenemented property with a common yard the importance from a sanitary point of view of having the yard surface covered with impervious material must have been obvious to both the owner and the Urban District Council. In my opinion the District Council should not have permitted the occupation of the dwellings seeing that building bye-laws have been violated, and in any case it is now their duty to take prompt steps to remedy the nuisances resulting from the unpaved yard and wooden ashpit.

During the last quarter I have on two occasions supported the District Council with my evidence in legal proceedings taken against the owners of insanitary property. Both cases were of some importance, and as the District Council were successful there will probably be less opposition on the part of property owners to the requirements of the Urban District Council in the future.'

LETTER FROM URBAN DISTRICT COUNCIL TO COUNTY COUNCIL.

Spennymoor,
12th November, 1902.

County Medical Officer.

DEAR SIR,

THE Council have duly considered the letter from the County Council, asking what steps are being taken to remedy the condition of things described in the report of the County Medical Officer of Health for the quarter ending 30th June, 1902.

The Council submit that they have never been slow to recognise the existence of insanitary conditions in the district, but on the contrary, as the work carried out during the past few years will shew, have earnestly endeavoured to grapple with the situation, and to create healthier conditions throughout the district. Unfortunately, even such a desirable undertaking can only be carried out gradually. The sanitary inspection of the district is carefully and systematically attended to, and the Council are always ready to take drastic measures, where necessary, to compel owners to carry out reasonable improvements.

With regard to the question of sewage disposal, plans for the enlargement and improvement of the present works are in hand, and application has been made to the owner of the adjoining land to lease the necessary land required.

Plans are also in hand for the sewage disposal works for Tudhoe and Ferryhill Wards.

I am also directed by the Council to state that Spennymoor does not stand alone in the matter of insanitary conditions, and the Council are far from thinking it is so notorious in this respect as the County Medical Officer's report indicates, and they doubt whether any similar Urban District can point to such improvements as have been carried out in their district during the last few years.

Yours faithfully,

FRED. BADCOCK.

Ralph Simey, Esq.,
Clerk of the County Council,
Durham.

No. 6.

App. A, No. 6

Sanitary Circumstances of Tyldesley-with-Shakerley Urban District, and on the prevalence of Enteric Fever therein; by Dr. R. W. Johnstone.

Report on the General Sanitary Circumstances of the Tyldesley-with-Shakerley Urban District, and on the Prevalence of Enteric Fever therein; by Dr. R. W. Johnstone.

The Urban District of Tyldesley-with-Shakerley has for some years past suffered severely from enteric fever, especially in 1901. The facts were brought under the notice of the Local Government Board through the annual reports of Mr. B. Blakemore, the Medical Officer of Health, and through the quarterly reports of the Registrar-General. In consequence, I received instructions to inquire into the enteric fever prevalence, and to report upon the general sanitary circumstances of the district.

The Urban District of Tyldesley-with-Shakerley lies about ten miles west of Manchester. At the census of 1901 its population was 14,843, the number of inhabited houses 2,869, the area 2,489 acres, and the rateable value £72,051 10*s*. The district is roughly quadrilateral, measuring about one mile and three-quarters from north to south, and about two miles and a half from east to west. Nearly the whole of the population is contained in the town of Tyldesley, situated on the western border of the quadrilateral. Tyldesley is practically continuous with the village of Hindsford in the Urban District of Atherton. The chief industries are cotton spinning and coal mining. Geologically, the district is on the Coal Measures, overlaid on the northern and southern borders by Boulder Clay. The soil on which the buildings in Tyldesley are constructed is of two kinds, sharply divided by Elliott Street, which runs along a ridge with the ground sloping away abruptly to the south and very gradually to the north. North of Elliott Street the soil is Boulder Clay or made ground, while south it is Red Sandstone rock, or a few feet of mixed gravel, sand, and clay, overlying the same rock. The Lancashire and Yorkshire and the London and North-Western Railway lines traverse the Urban District of Tyldesley-with-Shakerley.

General Sanitary Circumstances.

Dwellings.—Houses are for the most part two-storey brick buildings, with four rooms, two on each floor. On the whole they are well built, and kept in good condition. Back-to-back houses are being rapidly done away with. Not more than fifty are said to remain. Some of them which were formerly two-roomed houses, having one room on each floor, have been altered by making two adjoining houses into one. Two "hall" doors are retained, and a communicating door is made between the two

rooms on each floor. This method cannot be said to remove the inherent disadvantages of back-to-back houses. In other cases, where two houses standing back to back have at the instance of the District Council been made into one by breaking a door through the separating wall, there is a tendency amongst the inhabitants to live in one half of the reconstructed building and to let the other half to another family. The communicating door is then kept shut, and all the benefit of the Council's action is lost. There is no marked overcrowding of dwellings upon area, but cases of overcrowding of persons occur, and are dealt with by the Council's officers.

House and Court-Yards.—Some of the more recently-built dwellings have well-paved yards, but the great majority of house and court-yards in the district are conspicuously deficient in this respect. Many are paved with cobbles, which allow accumulation and soakage of filth between the interstices. Some are paved with stone flags which have become broken and uneven, while others are unpaved save for a narrow strip of flagging or other material skirting the house wall. Some yards are altogether unpaved. In a great number of cases the yards are soiled by house refuse strewn around the openings of the middens or ashpits. The construction and setting of the gullies which receive the slop stone waste is frequently so faulty as to cause fouling of the yard surface by overflow or splashing with slop-water, which either stagnates on the surface or fouls the soil by soakage.

Roadways and Passages.—Roads are generally paved with granite sets laid on ballast or ashes. As a rule they are not ill-kept. However, some of the bye-roads, even in the town of Tyldesley, are unpaved, and, owing to the clay soil, in a bad condition. There is a large area in the neighbourhood of Shakerley Common where there is no pavement, and the roads are at times almost impassable. This defect is being taken in hand by the Council. Footpaths are generally constructed of flagstones. There are about 25 miles of roadway repairable by the District Council, and about four miles which have not been dedicated.

Disposal and Removal of Excrement and House Refuse.—The chief method of disposal of excrement and house refuse is the privy-midden system. There are, however, about 150 water-closets, usually in the better-class houses, and there are some four or five hundred waste water-closets. The older middens are very large and often extend several feet below the level of the surrounding soil. They are nearly always roofed, but their contents are often in a moist or liquid condition, due either to leaky roofs or to the emptying into them of bedroom slops. Since the middens are almost invariably constructed of pervious bricks, they tend by soakage to produce a very foul condition of the soil around them. In addition some of them are so situated that they cannot be approached by a cart. In such cases the excrement is thrown upon the public roadway before it is loaded into a cart for removal. I observed on one road dark stains, left by an operation of this kind, which must have covered a space of about ten square yards. The waste water-closets are seldom in a cleanly condition,

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the descending tube being nearly always fouled with excrement. It is difficult to see how this tube can be kept clean without the use of a mop and pail. This class of closet has been introduced because the District Council have refused to supply water free of charge for flush water-closets. It is very doubtful whether there is any saving of water in waste water-closets as against ordinary water-closets.* They are more expensive to erect and to repair, and more liable to get out of order than the flush pattern, and they are certainly not so cleanly. It is, I think, to be regretted that the Council have encouraged their erection. Dry ashpits in connection with water-closets are sometimes not roofed over. The contents of middens and ashpits are removed periodically by the District Council, who retain a staff of twelve men and six horses and carts for this work. Removal is generally effected at intervals of two or three months. The coarse rubbish from middens along with dry ashpit refuse is deposited on a tip rented by the Council near Old Mill, Shakerley. The remaining refuse from the middens is disposed of to farmers, who accept it for use on their land.

House Drainage.—House drains are for the most part earthenware pipes, jointed with clay or with cement. Prior to 1894, cement was seldom used for this purpose. Waste-pipes from slop-stones are very often defective, allowing the slop water to dribble along the house wall and soak into it. The gullies which receive the waste-pipe are frequently placed too close to the house wall, and are not set in cement ar other impervious material. The ground around them is often in a sodden condition.

Sewers and Sewage Disposal.—All the houses in the Urban District, except those in its rural areas, drain to sewers. The sewers in side and back streets are 9 inches in diameter. The main sewer from the top of Common Lane to the outfall ranges in size from 12 inches diameter to 15 inches and 18 inches, ending in a culvert of 2 feet 6 inches diameter at Astley. A portion of the 15-inch sewer (300 yards) has been replaced by a 24-inch one, but is succeeded by an 18-inch sewer. There is a brick culvert (24 inches) extending for 480 yards from the junction of Charles Street and Factory Street, along Factory Street and Shuttle Street as far as Stanley Street. The sewers consist, except where above specified, of glazed pipes laid on the clay or rock. They take the whole of the surface water as well as the sewage, except for an 18-inch surface drain which was constructed in 1902 along Ellesmere Street to Oak Street, discharging into a brook.

The estimated dry-weather flow at the outfall is 300,000 gallons per day, but the storm flow sometimes rises to 1,000,000 gallons in the 24 hours. The fluctuations are thus considerable. Parts

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* Dr. Porter, late Medical Officer of Health of the County Borough of Stockport, together with the local Water Surveyor applied water-meters to two blocks of similar house property from October 28, 1896, to March 21, 1900—1,239 days in all. Block A consisting of 10 houses having waste water-closets, had an average of 4·575 inhabitants per house, and used 8·211 gallons per person per day during the 1,239 days. Block B, consisting of 14 houses having flushed water-closets, had an average of 5·625 persons per house, and used 8·250 gallons per person per day during the same period.

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of the main sewer, after leaving the town, are said to have suffered severely from subsidence of the soil in which they are laid. In places the flow of sewage is seriously impeded from this cause. In consequence of this and of the narrow gauge of some of the pipes (18-inch pipe succeeding 24-inch) there is considerable backing up of sewage in the town. Cellars in Shuttle Street and Union Street, which formerly drained to the sewers, were liable to flooding with sewage, and even after the drains were cut off cellars were seen flooded with a liquid suspiciously like sewage, possibly owing to percolation from faulty sewer joints.

There are a few ventilating shafts, but as a rule the sewers are ventilated through the down-spouting which is usually carried direct into the sewer, and which accordingly discharges sewer air under the eaves of the houses. Most of the manhole covers are unperforated, and the holes in many of those which are perforated are filled up with dirt. A few old sump holes still exist under manholes. Flushing is not carried out with any regularity, although all blind ends are said to be flushed weekly. There are no flushing chambers. The usual method is to introduce water from a hose-pipe by way of a manhole, and no attempt is made to dam the manhole by a penstock in order to create a rush of water. What flushing there is cannot, therefore, be of much use.

The sewage works and farm are at Astley. The farm is 166 acres in extent, but only 80 acres are used for sewage purification.

In times of normal flow all sewage undergoes the following process :—

(1.) Screening off the grosser solids and settling.

(2.) Treatment by the alumino-ferric process.

(3.) Treatment by passing through settling tanks, constructed with alternate baffle plates and weirs.

(4.) Either (*a*) treatment by downward filtration on land, or (*b*) treatment in bacterial filters.

Storm water is either sent direct on to the land or allowed to pass away untreated. The effluent from the farm and works discharges into the Black Brook, and ultimately reaches the Manchester Ship Canal.

There are eight bacterial filters, each 35 feet by 16 feet, and 3 feet 6 inches in depth. The effluent from them was very slightly opalescent and without smell, but I could not judge of the effluent from the land, nor of the normal condition of the Black Brook, because of the large quantity of storm water at the time of my visit. There are sludge presses used in connection with the settling tanks. The irrigation area is low-lying, and the soil stiff clay, on which the sewage often lies in pools.

Water Supply.—The water supplying the whole district is derived from the Manchester Corporation reservoir at Prestwich, on advantageous terms, under an agreement entered into in 1867. Three and a half million gallons per week are guaranteed.

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In 1868 the then Local Board agreed to furnish the Atherton authority with water up to 1,400,000 gallons per week.* The Council also supply water to Leigh Rural District. During the 12 months ending March 31st, 1902, the quantity of water supplied by Manchester Corporation to Tyldesley-with-Shakerley Urban District was 142,993,000 gallons, or about 2,749,865 gallons per week, and of this Atherton Urban District received 31,962,000 gallons, or about 614,654 gallons per week. During the same period 5,851,000 gallons or about 112,519 gallons per week, were supplied by Tyldesley to the Leigh Rural District. This left 105,180,000 gallons for the use of Tyldesley-with-Shakerley, of which 60,695,000 gallons, or about 11·1 gallons per head per day was supplied for manufacturing purposes, and 44,485,000 gallons, or about 8·1 gallons per head per day for domestic purposes.

I was informed that the District Council make a considerable profit on the water they supply to Atherton and Leigh. Nevertheless, up to the time of my visit they refused a free supply to houses in their own district having flush water-closets.

Slaughter Houses; Common Lodging Houses; Dairies and Cowsheds; Bakehouses.—There are 13 slaughter houses, 2 common lodging houses, 41 cowsheds, and 4 milk shops in the district. The slaughter houses seen by me were almost all faulty in the matter of pavement and channelling. In one of them pigs were habitually kept, and in practically all of them increased cleanliness was much to be desired.

One common lodging house was deficient in closet accommodation, and the other was dirty and overcrowded. I saw but few cowsheds, but those I did see were not altogether satisfactory. They were ill-ventilated and ill-paved, the floors and the cows were filthy, and in one case at least the cows were allowed to drink from a brook known to be polluted with sewage. The milk shops were on the whole clean and satisfactory, as were also the bakehouses seen by me.

Offensive Trades.—There are four tripe-boilers, but they work on a small scale, and only produce for local consumption.

Sanitary Administration.

The Tyldesley-with-Shakerley Urban District Council was formed out of the Tyldesley-with-Shakerley Local Board in 1895. There are 11 members in the Council, and the Health Committee meets once a month.

Adoptive Acts, Byelaws and Regulations in force in the District.—The Public Health Acts Amendment Act, Parts I., II., and III., the Infectious Diseases (Notification) Act, and the Infectious

* In 1902 Atherton, finding their pressure insufficient, erected a pumping station in connection with the 12-inch main at Hindsford, with the effect of draining the Tyldesley Council's main during pumping, leaving at times parts and, occasionally, the whole town without water, and causing the hydrant balls to fall for lack of pressure.

Diseases (Prevention) Act were adopted on October 1st, 1893. The following are the Byelaws in force in the district, with the dates of their respective sanction :—

With respect to	Nuisances and Refuse Removal		Aug. 18, 1898.
„	„	Common Lodging Houses ..	Oct. 13, 1898.
„	„	New Streets and Buildings ...	July 11, 1902.
„	„	Slaughter Houses	May 25, 1898.
„	„	Offensive Trades	Aug. 15, 1898.
„	„	Bakehouses	May 15, 1871.

Regulations concerning dairies, cowsheds, and milk shops have been in force in the district since February 1st, 1888.

No action has been taken by the Urban District Council under the Housing of the Working Classes Act, 1890.

Scavenging.—The cleansing of privy middens and ashpits, as well as the removal of their contents, is undertaken by the Urban District Council, who, as has been said, employ for the purpose 12 men with 6 carts. These men act under the directions of the Inspector of Nuisances. The usual method of cleansing the ash-pits and middens is to throw out their contents on to the surface of a back passage whence they are removed by the carts. When there is no back passage the midden contents are carried to the street by means of wheelbarrows, and deposited there pending removal by the carts. Wheelbarrow work, when necessary, is performed at night. A little carbolic powder is sprinkled in the empty middens and on the surface of the street where it has been soiled by the heaps of excremental matter.

To sum up briefly, it may be said that the chief causes of nuisances in the district are large offensive middens in connection with privies, together with the method of removing their contents. In addition, unpaved yards, defective or wrongly constructed down-spouting, faulty gullies, short or broken slop-stone waste pipes, and sewers of insufficient calibre, are obvious sources of nuisance.

Hospital Accommodation for Cases of Infectious Disease, and Disinfection of Infected Articles.—The Urban District of Tyldesley-with-Shakerley is one of the constituents of the Leigh Joint Hospital District, the other constituent members of which are the Borough of Leigh, the Rural District of Leigh, and the Urban Districts of Atherton and Goldborne. There are 17 members on the Joint Hospital Board, three of whom represent Tyldesley-with-Shakerley. The area of the Joint Hospital District is 24,352 acres, the population 86,254, and the rateable value £399,997. It was constituted in 1894. The Isolation Hospital is in the Tyldesley-with-Shakerley Urban District, and is situated at Astley, about two miles by road from the town of Tyldesley. There are 48 beds in the hospital, distributed as follows :—Two blocks, each containing two wards with eight beds in each ward, and two blocks, each containing two wards with four beds in each ward. There is also an adequate laundry, a good mortuary, a discharging

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block, and an administration block containing accommodation for a staff of 18. There is a Washington-Lyons steam disinfector, but it is not large enough for the needs of the whole joint district, and is practically only used for the work of the hospital. The buildings are permanent, and were in excellent order at the time of my visit.

The Joint Hospital Board have recently acquired a site in the Rural District of Leigh for the isolation of small-pox. They have erected on it a temporary hospital containing two wards, each with three beds. There is 2,000 cubic feet air space per bed. The nearest dwelling to this hospital is about 150 yards. There are about 50 dwellings within a quarter of a mile, and about 433 within half a mile.

Disinfection of houses is carried out by the Inspector of Nuisances, assisted by a man who works upon the roads when not required by the Inspector. The usual method is fumigation with sulphur, followed with limewashing by the occupier. Bedding and clothing are sometimes burnt with the consent of the owners; but beyond fumigation with sulphur no attempt is made to disinfect them.

Sanitary Staff.—The sanitary staff of the district consists of a Medical Officer of Health, who is engaged in private practice, and an Inspector of Nuisances, who is assisted in disinfection, as has been just said, by a road-man. The last named is also available for emergency work in connection with epidemic disease.

The Medical Officer of Health, Mr. Benjamin Blakemore, receives a salary of £60 a year; half of which is repaid from County funds. He devotes a considerable amount of time to his public health duties, and has an intimate knowledge of his district.

The Inspector of Nuisances, Mr. James Smith, receives £110 a year, half being repaid from County funds. He holds a certificate from the Sanitary Institute. He has the supervision of the cleansing of middens and ashpits, and he keeps the Health Office books. He is energetic and hard-working.

Vital Statistics of the District.

Before discussing the prevalence of enteric fever in Tyldesley-with-Shakerley Urban District, the vital statistics of the district, given in the following Tables (I., II., and III.), afford an idea of the general health of the district, and of the prevalence of enteric fever during the past 10 years.

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TABLE I.

Years.	Number of Deaths from				Population estimated to the middle of each year.	Death-rates per 1000 living.		
	All Causes.	Seven Principal Zymotics.	Enteric Fever.	Diarrhœa.		From all Causes.	From seven Principal Zymotics.	From Enteric Fever.
1892	239	18	2	7	13,120	18·216	1·372	·152
1893	250	65	3	44	13,307	18·787	4·885	·225
1894	192	28	2	5	13,495	14·227	2·075	·148
1895	293	55	6	18	13,687	21·407	4·018	·438
1896	265	57	9	6	13,882	19·089	4·106	·648
1897	218	29	4	8	14,079	15·484	2·060	·284
1898	246	48	10	18	14,278	17·229	3·362	·700
1899	294	66	12	16	14,481	20·302	4·558	·829
1900	278	39	3	6	14,687	18·928	2·655	·204
1901	283	47	7	26	14,895	19·000	3·155	·470
Total ...	2,558	452	58	154	139,911	18·283	3·231	·415

Deaths which occurred at the Leigh Joint Hospital amongst persons not admitted from Tyldesley with-Shakerly Urban District are omitted from the above table. Deaths of persons at the Leigh Union Workhouse who were admitted from this Urban District are included.

TABLE II.

—	The Death-rates per 1000 living for the whole period, 1892–1901, from				The Mean Population.
	All Causes.	Seven Principal Zymotics.	Enteric Fever.	Diarrhœa.	
Tyldesley - with - Shakerley Urban District.	18 447	3·260	·418	1·111	13,867

Table III.

	The Death-rates per 1000 living for the whole period, 1892–1901, from				The Mean Population.
	All Causes.	Seven Principal Zymotics.	Enteric Fever.	Diarrhœa.	
England and Wales ..	[illegible]	2·149	·174	·762	30,764,300
The 33 Great Towns ...	[illegible]	2·770	·193*	1·302	10,884,335

* Figures for "Fever."

Enteric Fever.

It appears from Tables II. and III. that the enteric fever death-rate in the Urban District of Tyldesley-with-Shakerley, for the period 1892–1901, was more than double that of England and Wales for the same period. Also it was more than double the "fever" rate for the 33 great towns. In 1891 there were 13 deaths from enteric fever in the Tyldesley-with-Shakerley Urban District, and in 1890, 5 deaths.

In Table IV. I have set out the number of attacks by enteric fever notified in the district in each year during the period 1894–1901,* together with the number of deaths.

Table IV.

	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Total in 8 Years.
Number of cases of enteric fever notified in the Urban District of Tyldesley-with-Shakerley.	13	36	48	29	67	43	51	77	364
Number of deaths from enteric fever in the Urban District of Tyldesley-with-Shakerley.	2	6	9	4	10	12	3	7	53

* The Infectious Diseases (Notification) Act was adopted in 1893.

The number of deaths which occurred amongst persons attacked with enteric fever during 1901 was 12, 5 of the cases proving fatal after termination of the year.

The distribution of the notified cases in the period 1894–1901 was fairly even throughout the town of Tyldesley, except for a remarkable immunity of the area lying between Elliott Street and the London and North-Western Railway line. Many of the dwellings within this area, however, were of a better class than elsewhere in the town, and consequently the locality was not, as a whole, so liable to recurring nuisances from middens, &c. In addition, the subsoil appeared to be of a less clayey nature than elsewhere. The differences between the soil and other conditions in this neighbourhood and in other parts of the town were considered in some detail; but, since they did not seem to lead to any definite conclusion, the details have been retained for future consideration, along with similar information from other districts in connection with a general inquiry into enteric fever, which is now being carried out by the Medical Department.

The following table shows the number of houses invaded in each month of the period 1894–1901. The dates are taken from the notification book of the Medical Officer of Health, and are, therefore, not the dates of invasion, but of notification.

TABLE V.

Years.	Number of houses* invaded by Enteric Fever during each month of the period 1894–1901.												Total houses invaded in each year.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
1894	2	–	1		–	–	–	2	1	4	–	3	13
1895	1	1		–	–	2	2	2	2	9	10	2	31
1896	1	–	4	2	1	1	4	6	2	3	7	9	40
1897	–	3	3	2	2	1	–	1	–	2	4	10	28
1898	2	1	2	5	3	–	1	1	6	23	11	2	56
1899	2	1	–	–	4	1	1	5	6	10	7	2	39
1900	3	2	1	1	6	3	1	3	6	11	9	4	50
1901	4	1	2	–	4	1	3	3	5	23	10	8	64
Total houses invaded in each month during the whole period.	15	9	13	10	20	9	12	23	27	85	68	40	321

* When a period of six months or over had elapsed between two invasions of the same house, I have reckoned two houses invaded.

This table shows the marked autumnal incidence of enteric in the district. I was unable to obtain figures to show the age and sex incidence during the whole period considered above.

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The facts, as far as I was able to obtain them for the period 1894–1901, do not point to any agency such as food, milk, or water, in the spread of the fever, but rather to some constant condition recurring year by year, and attaining its maximum power for evil in the autumn of each year. There may, of course, have been limited outbreaks of fever spread by food, milk, or water, during the period under consideration; but I was not able to obtain the facts necessary to investigate the question. A feature of the enteric fever incidence has been the manner in which it has recurred from year to year in the same houses. Reckoning houses with common middens as one house, there have been in the town of Tyldesley 30 instances in which the same house has been invaded from year to year. I visited 30 such houses and found that 19 had privy middens which were offensive from various causes, 20 had defective pavement in the yards, 12 had rain spouts communicating directly with the drains, and 16 had defects in the slop-sink waste-pipe, or in the gully beneath it, owing to which the yards were fouled with slop water.* Only two of the houses had, at the time of invasion, water-closets; but a few years ago there were hardly any water-closets in the district.

There were 15 occasions on which two or more notifications were received at the same time with regard to the same house, and there were 16 instances in which additional notifications were received from 14 days to six months after the receipt of a previous notification relating to the same house. I did not obtain information to show whether any relation existed for the whole period between the latter class of case, and cases that were nursed at home. In 1901, however, there were six cases in already-invaded dwellings occurring between two weeks and six months after notification of a first case, and in all instances the first case had been nursed at home. Practically all of the cases during the eight-year period occurred in artizans' dwellings.

Enteric Fever in Tyldesley-with-Shakerley during 1901.—There were 77 cases notified during 1901, and of these 12 died. There were 45 males attacked and 32 females. In 10 cases the age was not ascertained, but the remaining 67 are shown below :—

TABLE VI.

—	Under 5 years.	5–14	15–24	25–34	35–44	45 and over.	Total at all ages.
Number of persons attacked by enteric fever in Tyldesley-with-Shakerley Urban District.	4	16	21	9	10	7	67

* In some of these houses defects had at the time of my visit been made good. I have only counted defects which existed at the time of my visit, or about which I had positive evidence from the occupier or from the Inspector of Nuisances.

The number of houses invaded from month to month during 1901 is shown in Table V. There is the same autumnal maximum as in the eight-year period, and the same general distribution throughout the town of Tyldesley with the same exception of the locality between Elliott Street and the London and North-Western Railway line. The incidence from week to week during September, October, November, and December was as follows :—

1901.	September.				October.				November.					December.				
Week ended ..	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28	29-31
Cases notified ..	2	2	—	1	3	5	2	13	2	5	5	3	2		1	2	9†	1

† Five in one house.

Enteric in 1901 *in relation to Water, Milk, and Food.*—The general course and distribution of the epidemic did not give rise to the suspicion that water, milk, or food had been seriously concerned in its spread. The same water is supplied to the whole district, including the locality between Elliott Street and the London and North-Western Railway line. The possibility of local contamination of the water supply by means of breakages in the mains or in the service-pipes was considered. For that purpose a list of all the underground repairs made during the year was got out. There were 23 repairs to mains between April 1st and December 31st, 1901, but there were none during the month of September, and only two in October and one in December; none of these occurred in the neighbourhood of houses subsequently invaded by enteric fever.* In addition 23 service-pipes were repaired underground during the same nine months, but in no single instance did a case of enteric fever occur within a month at the house where repairs were made. The milk supply of the houses invaded by enteric during 1901 was obtained from 26 different sources, and the number of houses attacked in each milk round was roughly proportionate to the number of houses in the round. Moreover, the sex incidence did not point to milk as a factor in the spread of enteric fever during 1901.

Inquiry was made as to food supply, but nothing of importance was elicited. In one case cooked shell-fish had been consumed by a family, S——, and about 14 days later five of the members were attacked by enteric fever. It did not appear that all the members of the family who partook of these particular shell-fish subsequently suffered from enteric fever, nor that any other cases arose in the town from a similar cause, although shell-fish of this batch as well and other shell-fish had been consumed in Tyldesley. It also appeared that two children of the family, S——, had been suffering from diarrhœa for a month before the above-mentioned five attacks were notified.

* During 1902 there was much opportunity for fouling of the water supply through the lack of pressure and dropping of hydrant balls, referred to in a foot-note above, yet the usual autumnal increase of enteric was conspicuously absent.

Enteric Fever in relation to Coal Miners.—There was an idea locally that enteric fever was spread in the coal mines by means of dust blown through the pit by the ventilating apparatus. It was suggested that the dust might become polluted through unrecognised cases of enteric fever amongst the miners. If this were so, it would be expected that in comparison with the general population there would be a disproportionate number of miners attacked. I was not able to ascertain that more than seven miners suffered from enteric fever during 1901, or one in eleven (there were 77 cases during the year). According to the Registrar-General's returns, about one in five of the total population of Tyldesley-with-Shakerley is employed in mining, so that miners would appear to have suffered less, not more, severely than the other inhabitants.

Enteric Fever in relation to Rainfall.—The records of the rainfall in Manchester (the nearest available) were examined, but no definite relation of rainfall to the incidence of enteric fever in Tyldesley was discovered.

Personal Infection.—Six persons living in houses which had been invaded by enteric fever suffered from attacks which began more than a fortnight after the first case in the house had sickened. In every instance the first case attacked was being nursed at home. Inasmuch as no similar secondary cases occurred in houses where all previous cases had been removed to hospital, it seems reasonable to infer that the whole six were due to personal infection. If it were assumed that the two children of the S—— family, who were said to be suffering from diarrhœa, were really suffering from enteric fever, then five more cases might fairly be added to the number of persons who contracted enteric fever from personal infection during 1901.

I could obtain no data with regard to sub-soil water and its movements.

Special Measures taken by the District Council to Prevent the Spread of Enteric Fever in 1901.—Immediately a case of enteric fever was notified the Inspector of Nuisances called at the house, and as soon as possible had the midden emptied, sprinkled with carbolic powder, and the contents removed. A glazed earthenware pot containing about a pint of corrosive sublimate solution, one in 1000, was left for the patient's discharges. Each morning the pots were collected and the contents buried, a fresh pot being left at the patient's house. All these pots have air-tight covers. If possible, the patient was at once removed to hospital.* After the removal, recovery, or death of a case the house, clothes, bedclothes, &c., were fumigated by burning sulphur. In a few cases very foul bedding was burnt, with the consent of the owners. No compensation was paid or demanded.

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* Forty-two cases were removed to hospital during 1901, and 35 were nursed at home.

The cause of Enteric Fever prevalence in Tyldesley-with-Shakerley Urban District.—It would appear from the above that the cause of the prevalence of enteric fever in the district is not to be found in impurity of water, milk, or food supply, but rather in some condition of the dwellings, or of the soil surrounding the dwellings. It is certain that, owing to the privy middens generally in use throughout the district, to the methods necessarily used to empty them, to the numerous faulty slop-stone pipes and gullies, and to the lack of adequate pavement of yards, there is ample opportunity for the pollution of the soil around dwellings with filth. In the same way the soil around dwellings is liable to become infected with the specific bacillus of enteric fever, both by notified cases before their recognition, as also by cases that have not been recognised at all. If the bacillus of enteric fever can live and propagate in the soil and retain its virulence from year to year, enteric fever prevalence in such districts as Tyldesley-with-Shakerley cannot be matter for surprise. Nevertheless, assuming that specific pollution of soil and of privy middens near to dwellings has been the principal cause of the prevalence of enteric fever in the Urban District, I do not consider that the limited superiority of the area between Elliott Street and the railway in the matter of pavement of yards and construction of middens is sufficient to account for the remarkable immunity which that locality enjoyed. A further favouring condition must, I think, be sought, and this may perhaps be found in differences between the soil in this locality and elsewhere in the district.

Personal infection, as noted above, was concerned in the spread of the fever in a minor degree.

RECOMMENDATIONS.

The Urban District Council should take steps to substitute water-closets for the existing privy middens. In this connection it would be well if the District Council set an example to others by first setting their own property in order.*

Pavement of yards and proper construction of slop-stone waste-pipes should receive immediate attention.

Common lodging-houses, slaughter-houses, and cowsheds require more rigorous supervision.

Adequate means of disinfecting clothes and bedding should be provided.

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* I was sorry to note during my visit that property at Croft's Place, belonging to the Council, was in a very insanitary condition. The yard pavement was composed of cobbles, and there was a large and offensive midden, with leaky roof. It was usually emptied once in three months. The rain spouting communicated direct with the drain, and owing to a blocked gully and house refuse spilled near the opening of the midden the yard was in a filthy condition. This property was recently reported by the Inspector; but the Council, instead of converting the privy midden into a water-closet, as an example to others, decided only to line it with concrete. Five cases of enteric fever occurred here in 1898, and one case in 1900.

I have to thank Mr. Matthews, Clerk to the District Council, for information; Mr. Blakemore, Medical Officer of Health, for much assistance during the whole course of my inquiry; Mr. J. B. Smith, Surveyor, for maps and information as to the sewers; Mr. James Smith, Inspector of Nuisances, for statistical and general help; and Mr. Ginman, Gas and Water Manager, for information in connection with the water supply. I have also to thank Dr. Marsh, Medical Officer of Health to the Atherton Urban District Council. for information about Hindsford; and Mr. Ernest Williams, Clerk to the Leigh Joint Hospital Board, for information as to his Board's district.

No. 7.

REPORT on an outbreak of **EPIDEMIC SKIN DISEASE** at the **CENTRAL LONDON SICK ASYLUM, HENDON**; by **DR. S. MONCKTON COPEMAN.**

On 15th September, 1903, Dr. Downes received a letter from Mr. John Hopkins, F.R.C.S., Medical Superintendent of the Hendon Hospital of the Central London Sick Asylum District, to the effect that on his return from "leave" on the previous Wednesday (9th September) he found that "some 50 cases of epidemic dermatitis had occurred in the various wards of the Infirmary." He added "Fresh cases are cropping up still, but many of the earlier cases are recovering."

Dr. Downes at once communicated this letter to the Board, in consequence of which, on 18th September, I received instructions to investigate the circumstances of the outbreak.

Accordingly, I forthwith paid a visit to the Hendon Infirmary, as also on subsequent occasions, where I met Mr. Hopkins by appointment.

From him, together with his Assistant, Dr. Weir, and the Steward, I obtained all the information immediately available as to the progress of the outbreak and the various points of interest connected therewith.

In the first place I visited the various wards, accompanied by Mr. Hopkins and Dr. Weir, in order to examine the cases which at the time were under treatment, with the object of satisfying myself that they were undoubtedly similar in character to those which I had met with in the course of my previous investigations at other Poor Law Institutions.

Some of the cases had so far recovered that it was impossible with any certainty to diagnose their exact nature, but examination of other cases of more recent occurrence, and, in particular, one of special severity in an elderly female, left no doubt in my mind that these patients were suffering from the malady which in former reports I have described as "epidemic skin disease."*

In the present outbreak, however, the disease appears to have been in the majority of instances of a decidedly mild type, and for this reason, as the Medical Officer informed me, the true nature of the malady was not at first recognised, and indeed at the date of his departure for his annual "leave," although there were at that time as many as 21 cases in the Infirmary, they were,

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* "On an Outbreak of an Epidemic Skin Disease" (1895)—reprinted in the Medical Officer's Report for 1893–94—and "On an Outbreak of Epidemic Skin Disease in the Enfield Workhouse of the Edmonton Union" (1896).

according to Mr. Hopkins, so nearly uniformly scattered throughout the wards "and were for the most part of so trifling a nature, that they were supposed to be a little passing eczema." For this reason, probably, many of the cases were not entered in the clinical notes at the time of their first appearance, so that subsequent to Mr. Hopkins' return on 9th September, the dates could only be ascertained roughly from the statements of the patients and nurses, or from the date on which a prescription for the treatment of the disease was written on the bed card. I append a list* of all the known cases, 68 in number, which have been set down, so far as is possible, in chronological order of their occurrence. I also append clinical histories, abstracted by Mr. Hopkins at my request, of certain of the cases, including all those, comparatively few in number in the present outbreak, in which definite constitutional symptoms were observed.

In former epidemics which have come under observation in various Metropolitan Infirmaries the type of the disease has usually been of greater severity than in the present instance—so much so that severe constitutional symptoms have not unfrequently been noticed in the majority of those affected, while the death-rate has reached as high a figure as 10 per cent. In the outbreak now under consideration, on the contrary, only two deaths occurred, of which one can hardly be considered as due to the skin affection, although it is possible that the nephritis, from which the patient succumbed, may have undergone exacerbation as the result of diminished powers of elimination by the skin.

Cause of the Outbreak.

Following the method of examination which I have adopted in my former investigations, I made enquiries into the circumstances, not only of those persons who had suffered attack by the disease, but also of those other persons, both officials and patients, living on the premises, who had not been attacked, with the object of determining, if possible, the cause or causes which had brought about the epidemic.

In the first place it was noticeable that, as is invariably observed in similar outbreaks, all the persons attacked by the disease were, with few exceptions, of comparatively advanced age and the subjects of chronic ailments of one and another kind. And in this connection it may be stated that not one of the nurses,† porters, or other officials attached to the Infirmary contracted the malady.

I found, moreover, that all such possible factors in causation, as irritation of the skin from coarse body clothing, or newly-dyed and unwashed bedding, or from the use of bad soap, could be

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* Not reproduced.

† Mr. Hopkins has since informed me that two probationers suffered from small eczematous patches on the neck. These, he considers, may have been the subjects of the prevailing disease, in mild form.

eliminated. Infection from without may also in all probability be negatived, for the reason that all patients are transferred from the Cleveland Street Infirmary, where they are kept for varying lengths of time before being despatched to Hendon, and in one instance only, and that at a period subsequent (14th July, 1903) to the occurrence of the first cases, was a patient thus admitted who at the time was actually suffering from the disease. Personal infection from case to case may also be neglected in the present instance, seeing that patients are for the most part confined to bed; that they are not allowed access to wards other than their own; and that none of the nurses, so far as is known, suffered attack, even in mild form (*see* footnote, p. 2). In this connection, too, it is worthy of note that the Hendon Infirmary has only recently been built; that the wards are well isolated from one another; that they are kept admirably sweet and clean and are not overcrowded; and that all the sanitary arrangements appear to be in good order.

The question of dietary came early under consideration, for the reason that in a number of similar outbreaks at other Poor Law Institutions, which I had previously investigated, there appeared much reason for suspecting that the milk consumed by the patients had played some part in the causation of the disease. On enquiry, I learnt that in addition to milk there were two other articles of diet, viz., bread and butter, which are partaken of by practically all the patients in the Infirmary. Of these, the Medical Officer informed me that the bread is supplied by Chibnall, and was, in his opinion, above suspicion. The butter also, in his opinion, is of good quality; apart from which it is an interesting fact that case No. II. (Rosina M——) disliked butter, and had not touched it for over two months prior to attack.

Mr. Hopkins has supplied me with the following table, showing week by week, over a space of four months, the number of cases of skin disease which came under observation at Hendon :—

NUMBER of CASES arising per week, from January 1st to September 25th inclusive.

June.				July.				August.					September.			
Weeks.																
1st.	2nd.	3rd.	4th.	1st.	2nd.	3rd.	4th.	1st.	2nd	3rd.	4th.	5th.	1st.	2nd.	3rd.	4th.
1	0	0	1	1	3	0	4	7	4	8	5	11	8	10	4	3

From this table it will be seen that although a few cases occurred in June and the first half of July, it was not until the last week in the latter month that the disease appeared in epidemic form, while subsequent to the last week in September it abruptly and entirely disappeared.

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As Mr. Hopkins observes, "the coincidence in time of the disappearance of the malady and the suspicion openly thrown upon the milk is notable." As regards this statement, he informs me that neither he nor the Steward addressed any formal complaint in writing to the Contractor, but that the probable causal relationship to the disease of some unknown condition of the milk was openly discussed among the members of the Staff, and so cannot fail to have reached the Contractor through his employés. Mr. Hopkins returned to duty from "leave" on September 9th, and, for a few days, fresh cases of skin disease continued to present themselves.

All patients known to be suffering from the malady were now put on Swiss milk in place of the ordinary supply, and in Mr. Hopkins' words, "they all began to mend." On visiting the Asylum I suggested the isolation of all cases already affected and the substitution of Swiss milk for the whole of the contractor's supply. These suggestions were acted upon to the extent of isolating cases of the disease and changing the milk supply entirely in two of the wards. Notwithstanding, however, that the weather was somewhat "close" at this time, and that unless suspicion had already been aroused, the amount of preservative in the milk would hardly have been likely to be diminished, the outbreak terminated, as previously stated, somewhat abruptly, and before a sufficient period had elapsed to permit of obtaining definite evidence, as to causation, from the partial withdrawal of the suspected milk supply. And from October 4th the milk contract was transferred by the Guardians to new hands at the price of 1s. 9½*d.* per barn gallon of 16 pints—an increase of 4½*d.* per barn gallon over the previous contract.

According to Mr. Hopkins, at least half a pint of milk is included in the dietary of all patients, with very few exceptions, and among those few who had certainly consumed no milk there was no instance of the occurrence of the skin disease.

On the other hand, it is noteworthy that, with two apparent exceptions, all those patients who had been working in the ward kitchens for any considerable length of time suffered attack by the disease, and of the two patients who escaped, one disliked milk so much that she never took it. I have laid stress on the point of continuous employment in the ward kitchens for some length of time, because this probably implies, as I was informed, the opportunity for the consumption of considerably more than their ordinary allowance of milk. In which connection it will be observed, from the following table, that among a number of men who, at different times, worked for *short* periods only in the kitchens attached to two of the male wards, no cases of skin disease occurred. In reference to this apparent effect, in determining incidence of the malady, of length of service in the ward kitchens, Mr. Hopkins suggests that exposure of the skin to a continued high temperature may have predisposed to attack by the disease.

Inmates who had Worked in Ward Kitchens.

Ward.	Name.	Presence or Absence of Rash.
1	Ann T—— ...	No rash. Does not care for milk.
1	Marie B—— ...	Rash.
2	Rosina M—— ...	Rash.
2	Florence H—— ...	Rash.
3	Emma B—— ...	Rash. Works alone.
4	Mary C—— ...	No rash. Likes milk. Works alone.
5	William W—— ...	Rash. Two months in kitchen.
6	Several men ...	No rash. Worked each a short time.
7	Allen B—— ...	Rash. Two months in kitchen.
7	James S—— ...	Rash. Helps in kitchen at times.
8	Many men	No rash. Several work together, for a short time only, in shifts.

Two of the kitchen women referred to in this table, Rosina M—— and Florence H——, cared for little other food than milk, and, when attacked, both about the same time, begged that they might retain it in their diet. This, however, was not permitted, and on cessation of the milk diet they both commenced to improve, although still working in the kitchen.

Earlier in this report I have referred to the fact that the incidence of the disease was spread with remarkable uniformity over the various wards of the Infirmary, the female wards, however, being invaded to a slightly greater extent than the male wards—points which are illustrated by the following table :—

Table showing Number of Cases which occurred in each Ward.

No. of Ward	1F	2F	3F	4F	5M	6M	7M	8M
No. of beds in each Ward	39	36	36	36	36	36	39	36
No. of cases of each ...	8	13	10	9	7	6	7	8

In the open-air ward, No. 8, it may be noted that the quantity of milk consumed per patient is almost double that in any other ward, and yet the number of patients in which the typical rash

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was met with did not exceed the average for all the wards in the Infirmary. Moreover, there was no case in Ward 8 in which the rash practically involved the whole surface of the body. It is possible that the abundant fresh air and food supplied and the more perfect powers of digestion and assimilation possessed by these patients as compared with many of those undergoing treatment in the other wards may have proved more than sufficient to counterbalance any effect due to the larger amount of milk consumed by them.

The slight increase in the number of female over male patients attacked may perhaps be explained, apart from any question as to the dosage of milk, as depending on the slightly greater number of cases of skin disease ordinarily occurring in women than men; previous attacks of eczema, for instance, seeming undoubtedly to predispose to subsequent attack by the special malady under consideration.

At the time of the commencement of the outbreak, the milk was being supplied by a Mr. X of Mill Hill, at a price of 1*s.* 5*d.* per barn gallon "for an estimated quantity of 5,500 barn gallons," which, by the terms of the contract, was required to be "good, genuine, unseparated and unskimmed." This contractor is a farmer and keeps some cows of his own, but, as I was informed, the number is insufficient to supply the amount required under the Infirmary contract, even supposing that he did no other business. Under these circumstances it is obvious that he must have been in the habit of supplementing his supply from other sources, and indeed there is evidence that he received supplies of milk by rail, but whence or by whom consigned, I have been unable to determine.* This Mr. X had had a previous six months contract for the Infirmary, so that his milk had been in use since October 4th, 1902.

The Steward at the Infirmary is accustomed to test the milk twice daily with reference to the amount of cream contained in it, taking small quantities for this purpose from both the morning and afternoon deliveries. On looking through his note-book I found that the amount of cream apparently averaged about 9 per cent.; only on one occasion having fallen as low as 5 per cent. But I learnt both from the Steward and the Medical Officer that, about July 6th or 7th, 1903, it was noticed that the samples of milk, kept in the open graduated tubes for estimation of the amount of cream, remained quite "good" and uncoagulated for as long a period as three or four days, or even more, notwithstanding the facts that the weather was, just then, particularly hot, and that the tubes were kept on a table in front of a window where they were exposed to an especially high temperature. There is, therefore, very strong presumption that some preservative, in no inconsiderable quantity, had been added to the milk prior to its delivery by the contractor. In this connection it is also noteworthy that

* It should, however, be mentioned that on writing to Mr. X concerning this point I received a reply from him to the effect that *all* the milk supplied by him to the Hendon Infirmary was obtained from his own cows; and he added further, that no preservative of any kind was ever added to the milk or used for any purpose on his premises.

this contract milk, according to the steward, invariably possessed a faintish, slightly burnt smell, absolutely unlike that of good fresh milk.

This contract was determined by the Guardians as from October 4th last, but for two or three weeks previously, and probably in consequence of rumours as to possible implication of the milk in causation of the outbreak of skin disease, the amount of preservative was apparently lessened, with the result that, on September 24th, the afternoon supply was actually sour when delivered. The two churnsful (8 barn gallons), were at once returned to the contractor, who immediately sent back an equal quantity of milk, which, on being tested, proved to be of much better quality than that usually supplied. Under all the circumstances I considered it desirable to obtain a thorough analysis of the milk, even though it appeared probable that the resulting information would be somewhat less definite than might have been the case had such a step been taken early in July, for instance. For this purpose, the matter being one of urgency, I arranged with the Medical Officer at once to send two samples of milk (one each from morning and afternoon delivery) to Dr. Wilson Hake, who had been associated with me, for this purpose, in connection with similar investigations that I had carried out for the Board some years ago. Owing unfortunately to some mistake, it was not until September 29th that samples of the milk were actually sent to Dr. Hake, but, as will be seen from his report which I append, even at this date he was able to find distinct evidence of the presence of formalin in each specimen of milk examined.

This preservative is one which is being extensively used by milk vendors on account of its potency; only a small quantity being necessary for preventing milk turning sour; the amount ordinarily employed being apparently about 21 milligrammes per litre. Dr. Hake informs me that no less than 15,000 gallons of formalin (= formic aldehyde 40 per cent. solution) were sold in 1894 to milk vendors. The presence of formalin in milk, it may here be remarked, is specially undesirable for the reasons that (1) it retards or may even prevent pancreatic digestion altogether, while (2) it tends to combine with the proteids of the milk to form insoluble compounds, thus lowering the digestive value of the milk, apart from possible irritation of the intestinal tract.

Obviously it will be desirable, in any further outbreak of epidemic skin disease that may come under observation, at once to direct attention to careful chemical examination of the milk supply, more especially as regards the presence and amount of preservative of one or another kind. For, supposing that the action of added formalin, on the milk itself, and on the individual ingesting the milk, may hereafter be definitely proved to have some causal relationship to attack by this particular malady, it will be of interest also to elucidate the question as to whether other preservatives, such as salicylic acid or its congeners, may be similarly capable of giving rise to the appearance of this special form of dermatitis, in susceptible individuals.

In this connection the history of case No. XII. (*see* abstract of the clinical notes set out in the Addendum to this report) affords

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some reason for the belief that medical treatment of a patient at the Cleveland Street Infirmary, with certain intestinal antiseptics, caused the appearance of a generalized eruption of the skin, practically indistinguishable from that observed in cases of epidemic dermatitis. Confirmatory evidence is afforded by the fact that, on ceasing administration of the drugs, the eruption at once commenced to clear up, and had disappeared in little more than a week.

My former investigations of outbreaks of epidemic skin disease in each instance afforded strong evidence that the milk supply was, in some way or another implicated in the causation of the disease, but beyond this point further progress was barred by the absolute refusal of the milk contractors (for the most part apparently the same firm trading under different names) to afford any information as to the actual sources of supply. It proved impracticable, therefore, to eliminate the existence of some diseased condition of the cows or of some other mode of infection of the milk, either at its source of origin or subsequently. But as regards the outbreak at Hendon it would appear possible to exclude bacterial infection of the milk as having played a part in the causation of the malady, for the reason that the amount of preservative which obviously was being added to the milk about the time of the commencement of the outbreak, and which was sufficient to keep it apparently good for at least three or four days, notwithstanding the prevalence of high atmospheric temperature, would also have been likely to suffice for the inhibition and probable extinction of any pathogenic (and so probably non-spore-bearing) micro-organisms, supposing such to have been originally present in the milk.

It is matter for regret that, in previous investigations, the question as to the presence and, if so, the amount of preservative in the milk was not made the subject of inquiry, and even in the present instance unfortunately, beyond knowing that the amount must at one time at any rate, have been unusually large, no precise information is available. But in view of the facts observed at the Hendon Infirmary to which reference has already been made, and of the analytical evidence of Dr. Hake, it will be desirable that in the event of any further outbreaks of similar disease being reported the attention of a chemical expert should at once be directed to the detection and estimation of preservative, if any, in the milk supplied to the particular institution concerned.

It is possible also that information of value might be obtained by a carefully considered series of feeding experiments.

In view of the fact that the milk supply to Poor Law Institutions is often entrusted to contractors at a price considerably below that ordinarily exacted for good milk—in one instance, at Bethnal Green, I found the Guardians were paying thirteen pence per barn gallon !—and of the further facts observed as regards the milk supplied at Hendon, that the amount of cream averaged nine per cent. and that analysis showed that the milk was not apparently of obviously bad quality, it is perhaps worthy of note that a Dutch firm have recently introduced the manufacture of

artificial cream—"Calf-cream," as they term it—and that there is some evidence that the manufacture has already extended to England.

According to Lauterwald,* this material, when dissolved in water in the proportion of 50 grammes to 100 c.c., and mixed with about five times the quantity of separated milk, yields a product which has all the appearance of genuine new milk, from which also the ordinary methods of analysis are incapable of distinguishing it. The fraud can, however, be detected by the use of a special test devised by Baudouin.

Dr. Downes has been good enough to send to each of the Metropolitan Workhouses and Infirmaries a circular letter, asking whether, during 1903, any case of "exfoliative dermatitis" has been recognized. With few exceptions the answers have been in the negative. From five institutions one or two cases only, in each instance, have been reported, so that the Hendon Infirmary of the Central London Sick Asylum is apparently the only institution in which any outbreak, properly so called, has been observed during the present year.

It is perhaps a little difficult to understand why one institution only should be invaded after this fashion, if milk be actually the causative agent, and especially if the milk owe its disease-producing property to the presence of some particular preservative. But it may be that the avoidance by many Boards of Guardians of contracts with certain firms whose milk has come under suspicion on former occasions may have largely diminished the extent to which such milk is now supplied to Workhouses and Infirmaries.

But if the thesis as to the *rôle* of milk in the causation of this peculiar skin disease is correct, the fact that in one instance, at any rate, a patient was apparently admitted to the Cleveland Street Infirmary who, at the time, was actually suffering from the malady, would seem to indicate, as might perhaps have been expected, that it is not alone to Poor Law Institutions that milk possessed of such dangerous potentialities has been supplied. It is, however, especially in Workhouse Infirmaries that those persons who are evidently most liable to become affected are usually to be found congregated together—a fact which may perhaps account for the disease not having hitherto been generally recognized elsewhere.

S. MONCKTON COPEMAN.

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* Zeit. für Untersuch der Nahr. und Genusswittel, 1903, vi., pp. 544–548.

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ADDENDUM.

H. Wilson Hake, Ph.D., F.I.C., F.C.S.,
Lecturer on Chemistry at the W.H.M.S.,
Analytical and Consulting Chemist.

Chemical Laboratory,
Westminster Hospital Medical School,
Caxton Street, S.W.
October 24th, 1903.

S. Monckton Copeman, Esq., M.D., F.R.S.,
Local Government Board, Whitehall, S.W.

Report on two Samples of Milk received from Dr. John Hopkins, Central London Sick Asylum, Colindale Avenue, Hendon, N.W.

The samples were contained in 12-oz. bottles corked and sealed and delivered by hand on the 29th September, 1903, and were labelled respectively :— "8.30 a.m., September 29th, 1903," and "3.55 p.m., September 29th, 1903."

The usual analytical examination of the samples gave the following results, and for purposes of comparison I add the average of 120,000 samples (analyzed over a period of 11 years) by Dr. Vieth, the well-known authority.

—	Sample 1 (Morning).	Sample 2 (Afternoon).	Average of 120,000 Samples (Vieth).
Specific gravity	1030	1030	—
Total solids	12·32	12·05	12·9
Fat	3·83	3·93	4·1
Non-fatty solids	8·49	8·12	8·8
Ash	·79	·76	—
Cream	10 %	8 %	—

It will be seen from these figures that both samples are of somewhat poor quality, and that notably the non-fatty solids are below even the Public Analysts' average of 8·5.

The ash in both cases is high—a fact which I have not quite satisfactorily accounted for,* but traces of zinc were present in the morning sample which might partly account for it. Neither boracic nor salicylic acid were present, but both samples showed traces of *formalin* in small quantity which disappeared after a few days.

The fact that the milk supplied did not turn sour in the usual time may probably be thus explained, as it is well known that formalin exceeds all other "preservatives" in respect of retarding decomposition. The presence of traces of zinc in the ash of the morning sample suggests the use of some corrosive preparation, which may have been put into a zinc pail in the first instance.

H. WILSON HAKE.

* ? Due to presence of formalin in combination.—S. M. C.

CLINICAL NOTES OF CASES.

CASE I.

Ann M., aged 78, was admitted for inoperable cancer of the breast on October 4th, 1900.

August 3rd, 1903. A scaly condition of skin round about the hair on the forehead, temples, and behind ears. The skin is dry and rough from the presence of semi-detached branny or smaller scales. This has been noticed for a week or two.

September 16th. Has taken no milk for six weeks. The condition of the skin the same as on August 3rd.

October 30th. Exfoliation in frontal region at roots of hair. The rest of skin clear.

CASE II.

Rosina M., aged 19, admitted on June 5th, with lupus of face and arm. Has X-ray treatment. Subject to recurrent attacks of acne of face.

September 12th. Irritation of skin of body: on examination the back and chest are found to be erythematous, the redness being irregular and patchy. All the hair follicles are congested and infiltrated, but more so where the erythema is most marked. The limbs are free; but there is some itching of the frontal and occipital regions. Milk discontinued. Patient has not touched butter for two months past and has had very little at all since admission.

September 17th. Here and there individual follicles are enlarged over the back and form good sized papules; some few are pustular and the hair projects through the centre of the mattery head; itching said to have increased; much of the erythema has disappeared.

September 23rd. A few scattered papules only to be seen on back.

October 10th. Skin of back dry and rough to the touch, with lines of scratched epidermis.

October 30th. Itching persists.

CASE III.

Florence H., aged 28, was admitted on April 7th, 1903, complaining of epigastric pain, vomiting, hæmatemesis, and ovarian tenderness. Was better of these symptoms and working in the ward kitchen on August 30th, when she complained of itching of the skin of the legs, on which was found a rash.

September 12th. Papular rash on fronts of legs: a similar condition round the edges of the soles of the feet which are uniformly red and desquamating. Patches of minute papules faintly visible over trunk, more distinct on arms where there is slight desquamation. Itching severe:—milk discontinued.

September 17th. Itching intense, but rash dying away.

September 23rd. No papules now to be seen on legs; neither rash nor desquamation anywhere on trunk or upper limbs. No rash on soles which continue to peel.

October 10th. Still a few scales on soles of feet.

October 30th. Desquamation has entirely ceased. Still complains of itching.

CASE IV.

James S., aged 50, was admitted to Cleveland Street Asylum in 1897 with chronic ulcer of the leg, cirrhosis of liver, and incipient phthisis, and was transferred to this Sick Asylum on September 28th, 1903. Slight attack of hemiplegia on April 25th, 1902.

On August 23rd, 1903, a rash appeared on the elbows.

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September 15th. Rash most extensive now over the lower part of abdomen, in the groins and down the insides of the thighs; consists of well-defined patches that are slightly raised above the general level, of various sizes, some of the larger ones having a wheal-like margin as in urticaria, but there is no palor about the wheal; towards the groin the patches become thicker and confluent in places; on the left side in the iliac region, to which a fomentation had been applied, the part covered by the fomentation was uniformly red and had the raised defined margin already described as found in some of the patches.

A little scaling of same patches.

On the back are some ill-defined areas of congested and infiltrated hair follicles. Itching and burning of the bald scalp for the past three days, which looks dry and scaly and feels rough.

September 21st. Pustular eruption confined to a small area in frontal region of scalp. A few skin abscesses in right axilla, and the rash on lower part of abdomen becoming pustular.

September 23rd. Incisions required for several pustules.

Case V.

Mary Ann H., aged 87, was admitted to Cleveland Street Asylum on June 18th with eczema of leg, and transferred to Hendon Asylum on July 6th, 1903. On admission there was a large patch of eczema on the right leg; otherwise organs normal. Tongue furred.

August 3rd. Patient complains of irritation of leg. Eczema extends half round the leg and throughout more than half the length; it has a well-defined serpiginous-like edge and is covered with dry scales and sticks to dressing at places.

September 12th. Rash now extends over heels and soles to tips of toes, all being covered with large scales; on the arms are faintly red patches which are desquamating slightly, and the back is covered with pale red patches devoid of desquamation

October 30th. A good deal of desquamation still; thick scales on soles and toes; some branny scales on legs in patches; the original eczematous patch has been left much increased in size and now extends over the external malleolus.

Case VI.

Marie B., aged 32, was admitted to Cleveland Street Asylum on May 25th, 1903, with acute weeping eczema of posterior half of scalp; and dry eczema patches on upper half of back and chest and on hips.

Had never had a previous attack.

Internal organs normal. Temperature 103° F.

On June 2nd tranferred to Hendon Asylum.

Temperature normal.

A little bronchial catarrh.

August 3rd. Eczema of scalp, &c., is now well; but patient complains of great irritation of skin of limbs which is covered with abundant papules, &c.

August 5th. Discharge from left auditory meatus; both right and left meatus and external ear around each orifice is red and swollen.

September 12th. Whole surface of trunk and limbs rough from the presence of small pale papules—face, palms, and trunk exfoliating; scalp rough from the presence of dry scales and scabs.

September 17th. Skin abcesses in both axilla.

Inside of right arm covered with closely-set small red papules; desquamation less.

September 29th. Discharged; desquamating still.

Epidemic Skin Disease at the Central London Sick Asylum, Hendon; by Dr. S. M. Copeman.

CASE VII.

Alfred A., aged 27, was admitted on January 22nd, 1903, suffering from phthisis. Under open-air treatment increased in weight from 7st. 13½lbs. to 8st. 12½lbs., when on June 28th an eruption of closely-set vesicles appeared on the palms and fingers, which becoming confluent in places, led to the formation of bullæ and raw surfaces freely weeping. He also had a patch on the leg which wept. Exfoliation followed.

On August 2nd an eruption appeared on the wrist in which the hair follicles were involved, forming papules, some running into pustules presenting a central hair.

October 26th. This rash persisted for some weeks. The soles, on which no eruption was observed, peeled as well as hands, and the skin of the palms presented dry puckered and rough patches. At present there is some peeling (branny) of the forehead and cheeks, but the desquamation has ceased elsewhere.

The patient has slowly but steadily lost weight since June 28th. On October 14th his weight was 8st. 5½lbs.

For seven years past has been subject to attacks of eczema.

CASE VIII.

Mary L., aged 63, admitted to Cleveland Street Asylum on July 11th, 1903, stated that she had been discharged from Hendon Asylum on May 27th last, having been an inmate for 10 days; that the legs and ankles have since become swollen and painful, and there has been great itching of skin all over.

On examination, the legs were found slightly swollen and bearing evidence of scratching.

July 14th transferred to Hendon Asylum; where on admission the œdema of the legs was found to have subsided, but there was an irritable rash on arms, legs and back. From this date the rash appears to have increased until August 9th, when it is noted that "the papular eczematous rash is all over the back; on both feet there are some bullæ; in one or two the fluid seems to be purulent."

September 11th. Over trunk and limbs are papules scattered and in groups; on feet and hands are numerous vesicles, confluent and forming bullæ; and there is much discharge; the skin of the palms and soles is rough from deeply-set vesicles; the scalp is red, and itching is general and severe.

This patient was an acute case and had a variety of treatment for two months without sign of improvement. On September 11th, the milk was stopped from her diet, and on September 23rd the legs, which a week ago were covered with thick yellow crusts (all dressings had been removed), are much better; the skin is now covered with thin scales that are separating at their edges; the legs and toes here and there still weep; the soles are desquamating, the hands are dry except on one or two spots; the forearms are still red and rough on exterior surfaces principally; the body rash is subsiding; the face and neck have reddish areas still upon them; and there is considerable itching.

October 30th. Still some desquamation of feet and legs, and patches red and excoriated on legs.

CASE IX.

Louisa C., aged 60, was admitted on January 30th, 1903, suffering from chronic nephritis, high arterial tension, cardiac hypertrophy and irregularity.

July 28th. Eczema of legs, scalp and forearms has been noticed for the past two months and was first treated on June 1st.

August 3rd. Much improved.

August 8th. A rough symmetry about the rash; itching has been severe; now better somewhat of that; on thighs are very large indurated papules, and pustules. Some of the latter have been scratched and emptied of their contents and present deep pits in their centres; the exterior surfaces only are affected.

August 31st. The rash has much improved.

September 4th. Attack of dyspnœa and death in three-quarters of an hour. Post-mortem. Chronic interstitial nephritis. Fatty left ventricle; two rows of small vegetations on the auricular side of the ventral orifice.

Case X.

Charlotte F., aged three years, was admitted on May 20th, 1902, being extremely small, physically of very feeble type, the subject of congenital syphilis, rickets, enlarged tonsils and lymphatic glands and conjunctivitis. Was ill-nourished and anæmic, and weighed 10 lbs. 3 oz.

Had in August, 1902, some specific eruption on nates.

November 23rd, 1903. A bilateral, almost symmetrical, rash, forming well-defined oval, red, and slightly-raised patches, one on each side over the lower part of the ribs posteriorly, and one on each forearm at its inner and posterior aspect.

This rash had disappeared under treatment on July 15th, when a fine papular rash came out on the face, arms and legs. The temperature rose on the evening of the 14th to 101·2° F. and next morning to 102·4° F. In a few days the child was well again.

August 14th. Weight = 1 st. 4 lbs. Child seems in good health.

August 30th. The body covered with scaly erythematous rash for the past seven or ten days. A large patch on the right cheek and chin.

September 29th. The rash consists chiefly of definite patches of dermatitis. Temperature = 104·4° F. last night.

October 20th. Desquamation, which has been general, has now almost ceased.

Case XI.

James I., aged 74, admitted on May 4th, 1903, suffering from albuminuria, weak heart and bronchitis, was feeble and without taste for food, which he failed to recover.

September 22nd. Has been obviously failing in health for a month past. He now lies prostrate and drowsy and has slept a good deal for a week past. Tongue clean. No vomiting. Complains of pains in the limbs.

For a week past there has been general desquamation, which is very free. There is erythema of the right arm and forearm. The palms and soles are peeling almost in one piece.

September 25th. The drowsiness increased and patient died on this date.

Case XII.

Fridis L., aged 58, was admitted to Cleveland Street Asylum on September 7th, 1903, suffering from incarcerated umbilical hernia. Vomiting and collapsed.

From this she was relieved, but diarrhœa supervened and persisted. On September 12th resorcin gr. 10, quartis horis, was prescribed, and on the 16th she was given salol gr. 10 t.d.s.

This was followed quickly (within a day or two) by a bright erythematous rash on the face, ears, and neck, trunk and limbs. Under the belief that this was the effect of the internal antiseptics, these were discontinued (date not quoted), and the erythema disappeared in a few days.

September 28th. Fine papery desquamation of forehead, forearms, and legs.

October 21st. All signs of desquamation have ceased.

No. 8.

Report on RE-INSPECTION of the BOROUGH of WHITEHAVEN and on RECENT ADMINISTRATION therein: by Dr. REGINALD FARRAR.

APP. A. N.
Re-inspection of Borough of Whitehaven by Dr. R. Farrar.

In July, 1902, my colleague, Dr. H. Timbrell Bulstrode, reported to the Board upon an outbreak of enteric fever in the Borough of Whitehaven, and upon the sanitary administration of the Town Council.

On receipt of this Report the Town Council of the Borough of Whitehaven appointed a sub-committee of their Street and Sanitary Committee to consider it, and subsequently appointed two of their number to make a detailed inspection of the Borough in conjunction with this sub-committee.

The report of this sub-committee containing their observations on Dr. Bulstrode's report, together with a detailed account of their inspection of the courts and alleys of Whitehaven, was received by the Local Government Board on December 11th, 1903.

With reference to this report of the sub-committee I received the Board's instructions to visit Whitehaven and ascertain what sanitary progress had been made in the Borough since the date of Dr. Bulstrode's report.

I visited Whitehaven on February 22nd and on subsequent dates, and have the honour to report as follows:—

Water Supply.—This has been fully dealt with in Dr. Bulstrode's report. The Council have now a lake works inspector who resides at the lake side. He submits to the Borough engineer and surveyor a weekly report upon the height of water in the lake, the condition of the gauge, the rainfall, and other matters. He also inspects and reports any nuisances which may occasionally arise in the vicinity of the lake.

With the question of *Sewerage*, which has been fully discussed in Dr. Bulstrode's report, it is not necessary to deal further.

House Drainage.—In very many instances drains pass under the houses. The sub-committee acknowledge this fact, but maintain that in an old constructed town like Whitehaven it is impossible to avoid this. Whenever a defect arises in a house, the Council cause any drain which passes under it to be embedded in concrete and properly ventilated.

Notices to repair defective drains, gulley traps, &c., are served upon owners of premises immediately cases are reported to the Street and Sanitary Committee by the Inspector of Nuisances.

No. 8. ction gh of ven ;

Nevertheless I found numerous instances in which there was an obvious escape of sewer air under the floors of houses, indicating the passage of defective drains under them.

In the majority of courts and alleys the dwellings are unprovided with sinks, and the occupiers can only dispose of their slops by throwing them down gulleys in the passage between the houses. Where sinks exist in the poorer dwellings they are frequently placed in the cellar and are not disconnected, but connect with the sewer with only the intervention of a U-trap. These traps must be liable to be forced when there is any pressure of sewer air in the drains.

Excrement Disposal and Removal.—In this direction the Town Council have displayed a laudable activity. During the past three years plans for 181 additional water-closets have been passed; 156 have been erected, and the remainder are in course of erection.

The Town Council are endeavouring to attain the standard of one water-closet for every two houses. (In consequence of the very narrow space available the new water-closets are somewhat obtrusively in evidence, and tend to further block the courts.) In most cases, but not in all, where new water-closets have been erected, ventilating shafts to the drain have also been provided. The new closet pans are in some cases of the wash-down short hopper type, in others of long hopper type.

There still remain, however, a large number of dwellings in which the water-closets are in altogether improper situations, *e.g.*, unventilated closets in cellars, opening directly into living rooms, or wedged into narrow staircases between living rooms. In several such cases, as I have said above, there was obvious nuisance clearly indicating the escape of sewer air from leaky drains.

I found also several cases of tenements the occupants of which could only reach their water-closet by going out into the street and round two corners into an adjoining court.

This arrangement is highly objectionable, especially in cases of illness.

Refuse Disposal and Removal.—Scavenging is on the whole properly attended to. The capacious ashpits referred to in Dr. Bulstrode's report still exist in some parts of the town, and though they are emptied daily they constitute in my opinion an objectionable feature.

Slaughter-houses.—These are now regularly inspected, and Dr. Bulstrode's specific recommendations have been attended to. The bye-laws are strictly enforced.

As pointed out by Dr. Bulstrode, the provision of a public abattoir is a measure much to be desired for the good of the town, if the occupiers of the old slaughter houses could be induced to give them up and use the public abattoir. There is a market belonging to the Earl of Lonsdale in which several lots are now used as private slaughter-houses. This property is conveniently situated near the public markets, and if it could be acquired the

site would serve admirably for a public abattoir, particularly if the adjacent block of buildings were acquired and pulled down to enlarge the site.

Common Lodging-houses.—These are now regularly inspected and are kept clean. Dr. Bulstrode's recommendations as to the provision of water-closets and lavatory and laundry accommodation have been attended to. The bye-laws are strictly enforced with the exception of bye-law 21, which forbids the occupation of any bed by two persons of the same sex over the age of 10. This is habitually disregarded in all the four common lodging-houses which each contain several beds habitually occupied by two men at once.

The common lodging-house rented by Anne McLaughlin, in Nicholson's Lane, has floors in a ruinous condition. It is in an obstructive block and should in my opinion be pulled down.

Dairies, Cowsheds, and Milkshops.—In respect of these Dr. Bulstrode's Report has been considered by a Special Sub-Committee, and notices have been served upon the keepers of cowsheds where the latter were found to be defective to do the following works, viz. :—

To provide better means of ventilation, lighting (by windows), and drainage, and also to cleanse in those cases where the cowsheds were not kept clean.

The Sub-Committee have also directed the Town Clerk to amend the existing regulations, and to incorporate such new bye-laws as are necessary for the requirements of the Borough with a view to the same being considered by the Committee, and submitted to the Local Government Board for approval.

Isolation Hospital Accommodation.—This is sufficiently dealt with in Dr. Bulstrode's Report. The improvement of the provision of hot water at the hospital is receiving the attention of the Hospital Sub-Committee.

The Housing of the Whitehaven Poor.—It was to this question that I principally directed my attention in my inspection of Whitehaven.

The Town Council have already displayed considerable activity in remedying some of the more gross sanitary defects in these courts and alleys. I found however at the date of my inspection many gross insanitary conditions still in existence, the majority of which I consider it would be impossible to remedy without demolition of the tenements involved.

The improvements effected have been as follows :—

Additional water-closets.—As stated above a large number of additional water-closets have been provided.

Ventilation.—In houses which have required ventilation, sash-frames or swivel sashes have been substituted for fixed windows. Most of the tenants appear, however, to keep these windows closed night and day, and as the great majority of houses consist

E. A. No. 1.

Inspection Borough of Whitehaven: Dr. R. [illegible]

of back-to-back tenements utterly devoid of through ventilation, the problem of ventilation cannot be considered to have been thereby solved.

Lighting.—Several courts have been provided with electric light, but far too many are still left in darkness. The total darkness of the approach to these courts at night is not only a grave inconvenience to the tenants, but is productive of nuisances and conducive to immorality.

Rain spoutings which drained direct into sewers and which ventilated under the eaves have been cut off in a number of cases, but many are still left. In numerous instances the rain-spouting discharges, not over a trapped gully, but on to the pavement, and the rain from the roof soaks into the ground between the cobbles of the pavement.

Paving.—Several courts have been repaired with blue bricks in substitution for defective boulder pavement.

Obstructive walls.—In certain courts obstructive walls have been lowered or altogether pulled down.

Repairs to roofs have been effected and other structural defects have been remedied in many cases.

Closing of certain houses and courts.—The sub-committee have recommended that certain houses (in six courts) be closed "until rendered fit for human habitation," and that four courts be closed.

Credit is due to the Town Council for the energy they have shown in thus remedying sanitary defects in detail, but they have not grappled with, and hitherto have shown no disposition to grapple with, the larger problem involved in the gross overcrowding of houses on area.

Explanation of overcrowding of houses on areas.—This may be best explained by adverting to the fact that Whitehaven was, in the eighteenth century, a well laid out town, with wide streets and well built houses, having each a strip of garden, of the width of the house, at the back. When, owing to the development of collieries, &c., the town increased in population, and it was found impossible to obtain land for building from the Lord of the Manor outside the limits of the town, owners of house property were induced to run up blocks of ill-contrived back-to-back houses in what had been originally gardens. Population still increasing, any interstices that remained between these blocks and the original houses were filled up with smaller tenements, wedged in wherever room could be found.

Opening out of the main streets are a succession of squalid alleys and courts approached by passages which are less than three feet in width. These passages lead to networks of tenements in back-to-back houses, the occupants of which are in gloom the whole year round.

Hardly a single house in the courts has any through ventilation. Those that are not back-to-back are built against dead walls

of larger houses, or against the cliff face. A very large proportion of these tenements face a blank wall less than three feet from their front, or look into their neighbours' windows from a similar distance. Of the 166 courts and alleys enumerated in the sub-committee's report I personally inspected 150, and in more than 120 I noted obstructive houses or blocks. Some of the worst have been closed; others have been unoccupied for years; the closing of others is recommended by the sub-committee.

Medical Officer's Report.—The Medical Officer of Health says in his report for 1902, "There are a large number of houses which I would unhesitatingly condemn if only provision could be made for the people so displaced, but under existing circumstances any wholesale closing of houses would result only in overcrowding those that remained, and which might be little better than those closed."

As a result of my own inspection I estimate that there are at least from 120 to 200 houses, mostly in back-to-back blocks, and in every case without through ventilation or proper lighting, which ought to be demolished, not only as insanitary in themselves but as obstructive dwellings.

To deal comprehensively with the housing problem in this town by means of a single scheme would probably be, for financial reasons, impracticable. In order, however, that more light and air may be accorded to the inhabitants of the most crowded passages and alleys, it is necessary that certain houses, or groups of houses, should be demolished; and if this process were gradually applied and houses erected outside the town limits to accommodate the tenants thus displaced, a very material improvement might be effected in the present state of affairs.

In order to carry this proposal into effect it would be necessary to take action under Part II. of the Housing of the Working Classes Act, 1890.

Some 104 cottages for workmen employed in the colliery were erected a few years back at Kells by the Earl of Lonsdale. These cottages, 4-room and 5-room dwellings, are admirably planned and in an excellent situation; they let at 3*s.* 6*d.* to 4*s.* a week.

If from 50 to 100 similar cottages, or even rather smaller, were erected in the neighbourhood of Kells, where land for the purpose could be acquired, and a corresponding number of houses in the centre of Whitehaven demolished, some progress in the housing problem would have been effected.

It is suggested that the Colliery Company, if approached, might not be unwilling to take measures, in concert with the Town Council of Whitehaven, for the erection of cottages for their employees, many of whom are housed at present in the squalid slums of Whitehaven.

I may point out that if my suggestions were adopted, not only would those benefit who were housed in new cottages, but also those remaining in alleys and courts to which the demolition of

existing obstructive houses or groups of houses would let in light and air.

Credit is due to the members of the sub-committee and to the Town Council for the activity in remedying some of the worst defects pointed out in detail in Dr. Bulstrode's report, but it cannot be too strongly urged that the work thus done has been of the nature of patch-work expended upon a fabric which is in need of radical reconstruction.

The squalor, moral, physical, and social, which at present exists in the slums of Whitehaven has not been effectively diminished by the work so done, for the condition of the town is such that no measure short of an effective scheme of demolition and the provision of additional house accommodation in suitable sites beyond the area at present inhabited will be of permanent benefit.

I cannot but express the view that if the Town Council delay longer to face this urgent problem they will be displaying an inadequate sense of corporate responsibility.

In conclusion I wish to express my thanks to Mr. Brown, the Town Clerk; Dr. Fisher, the Medical Officer of Health; and to the officers of the Corporation, for assistance rendered me in my investigations.

No. 9.

MEMORANDUM PREPARED by the **MEDICAL OFFICER** and **CIRCULARS ISSUED** by the **LOCAL GOVERNMENT BOARD** in 1903 relating to **PUBLIC HEALTH** and **VACCINATION.**

APP. A, N
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A. MEMORANDUM :—

Memorandum on the Circumstances under which the Closing of Public Elementary Schools or the Exclusion therefrom of particular Children may be required in order to prevent the Spread of Disease.

B. CIRCULARS :—

(1) Vaccination Acts, 1867 to 1868. Recovery of Penalties To Boards of Guardians in the Metropolis. (28th January, 1903.)

(2) Small-pox. Casual Paupers. To Extra-Metropolitan Boards of Guardians. (9th February, 1903.)

(3) Midwives Act, 1902. To County Councils and Town Councils of County Boroughs enclosing memorandum on the Act. (27th April, 1903.)

(4) Disused Army Blankets imported from South Africa suspected as being specifically infected by discharges from enteric fever patients. To certain Town and District Councils. (25th May, 1903.)

A.

Memorandum, prepared in the Medical Department, on the Circumstances under which the Closing of Public Elementary Schools or the exclusion therefrom of particular Children may be required in order to prevent the Spread of Disease.

Objects of
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1. It is attempted in these notes to bring together the information in the possession of the Local Government Board, derived from the reports of the Board's own Medical Inspectors and of local Medical Officers of Health, respecting school-closure and exclusion from school as precautions against infection, with a view to indicate the best means of preventing the spread of disease by school children among their fellows, while avoiding any unnecessary interruption of the work of education.

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Memoranda and Circulars issued in 1903.

Regulations of Board of Education.

2. In the Provisional Code of Regulations issued by the Board of Education in 1903, the following Article (Art. 88) prescribes, as one of the general conditions required to be fulfilled by a Public Elementary School in order to obtain an annual Parliamentary grant, that—

"If the Sanitary Authority of the District in which the school is situated, or any two members thereof acting on the advice of the Medical Officer of Health, require either the closure of the school or the exclusion of certain children for a specified time, with a view to preventing the spread of disease or any danger to health likely to arise from the condition of the school, such requirement must at once be complied with, but after compliance appeal may be made to the Board (of Education) if the requirement is considered unreasonable."

Article 83 (a) prescribes that "if a school has been closed during the "year under medical authority, or for any unavoidable cause, a corres- "ponding reduction is made from the number of meetings (400 a year) "required."

(The "medical authority," referred to in this Article is not necessarily that of the Medical Officer of Health.)

Epidemic grant withdrawn.

Article 101* which provided that where the Board of Education were satisfied that by reason of a notice of the Sanitary Authority under Art. 88, or any provision of an Act of Parliament, requiring the exclusion of certain children, or by reason of the exclusion under medical advice of children from infected houses, the average attendance had been seriously diminished, and that consequently a loss of annual grant would, but for this Article, be incurred, the Board should have power to make a special grant not exceeding the amount of such loss in addition to the ordinary grant, has ceased to operate since March 31st, 1903.

Diseases principally requiring action.

3. The diseases for the prevention of which school closure, or the exclusion of particular children, will be required are principally those which spread by infection directly from person to person, such as diphtheria, scarlet fever, measles, whooping-cough, epidemic influenza, small-pox, and rötheln. More rarely, the same questions arise in connexion with enteric fever and diarrhœal diseases, which spread not so much by direct infection from person to person as indirectly through the agency of local conditions, such as infected school privies.

4. It will be seen that Article 88 quoted above confers upon sanitary authorities an alternative power with respect to public elementary schools.

(A.) To cause particular scholars to be for a specified time excluded from attendance, or

(B) To require the school to be closed for a specified time.

Exclusion of scholars:

5.—*A. First, as to exclusion from school of particular scholars.*—Here it will be convenient to consider the circumstances under which the requirements of the public health will be satisfied by the less severe measure of the exclusion from school of particular children.

(*a.*) It may be laid down as a universal principle that all children suffering from any dangerous infectious disorder (*i.e.*, of a nature dangerous to some of the persons attacked by it, however mild in other cases) should be excluded from school until there is reason to believe that they have ceased to be in an infectious condition (*see* section 126 of the Public Health Act, 1875).

from infected houses,

(*b.*) Furthermore, as it is rarely possible to provide effectual separation of the sick from the healthy within the homes of children of the class attending public elementary schools, it must commonly be necessary that all children of an infected household should be excluded from school; first, because otherwise such children might attend school while suffering from the disease in a latent form, or at an unrecognized stage, and, secondly, because it is known that infection may attach itself to, and be conveyed by, the clothes of a person living in an infected atmosphere, even though the person himself remain unaffected.

from particular localities.

The same considerations will sometimes make it desirable to prohibit the attendance at school of all children from a particular street or hamlet.

In the case of infectious diseases involving little or no danger to life, ich as mumps or skin diseases, school interests may be more particularly

considered. In such case, however, it will usually be well for the Medical Officer of Health to advise the managers to prohibit the attendance of every child while in an infectious state.

Closing of schools.

6.—*B. Secondly, as to the closing of schools.*—This, by more seriously interfering with the educational work of a district, is a much more grave step for a sanitary authority to take than to direct the exclusion of particular scholars. It is a measure that seldom ought to be enforced, except under circumstances involving imminent risk of an epidemic, nor even then as a matter of routine nor unless there be a clear prospect of preventing the propagation of disease such as could not be looked for from less comprehensive action.

when to be required.

The mere fact that in an epidemic many of the sufferers are school children does not necessarily show that the disease was caught at school; but the school may with probability be regarded as spreading infection if in a large majority of households attacked the first case be a child attending school; and with still greater probability if a number of children living at a distance from one another, and with no circumstances in common, except that they attend the same school, should be simultaneously attacked, and if it can be ascertained that a child or teacher in an infectious state has actually been attending the school.

Duty of Medical Officer of Health when infectious disease occurs.

7. By Article 18 (6) of the Board's Order of 23rd March, 1891, the Medical Officer of Health on the occasion of an outbreak of dangerous infectious disease is to advise the persons competent to act as to the measures to be taken to prevent the extension of the disease. If, therefore, he finds that the children of infected households are attending school, he should send notice of the fact to the schoolmaster, and give such advice as appears to him to be necessary with regard to the exclusion of the children from school, and as to the time for which such exclusion should continue.

Where the number of children to be excluded is small, and the schoolmaster acts on the advice of the Medical Officer of Health, it may not be necessary to take formal action under Article 88 of the code; but where the number of children whom it is desirable to exclude from school is such as is likely seriously to diminish the average attendance, or where the advice of the Medical Officer of Health is not followed, and there is danger of the disease spreading by means of the school, notice for the exclusion of the children in question should be made in accordance with the requirements of Article 88.

Aid which schoolmasters and others can give.

The attention of school attendance officers and of schoolmasters should also be drawn to the following considerations. Frequently they themselves will obtain the earliest information of the occurrence of infectious disease among scholars, and it is most desirable that such officer or master should without delay communicate the facts to the Medical Officer of Health. Absence of any child from school on the plea that it is suffering under one of the before-mentioned diseases, and absence of several children of one family from school at the same time, no matter what name be given to the complaint that keeps them at home, should be reported to the health officer. In practice it has been found that this notification of absentees has materially aided the local health officer in taking measures for the suppression of infectious disease, to the advantage alike of the district and of the school. Furthermore, schoolmasters may properly be asked to take note, especially when an epidemic threatens or is present, of symptoms occurring in any of their scholars that may indicate the commencement of disease, febrile in nature. Besides heat of skin, such symptoms are shivering, headache, and languor, especially if commencing suddenly, vomiting, rashes on the skin, and sore throat. When scarlet fever or diphtheria is about, every trace of sore throat should be looked upon as suspicious. In any case where such symptoms are observed, the safest course will be to exclude the child from school until assurance can be had that it may attend school without harm to itself or danger to other scholars.

Exclusion of particular scholars; duration of.

8. As regards duration of exclusion from school of particular children, the time to be specified will vary in different diseases and different cases, and in this matter the sanitary authority will doubtless be guided by the advice of their Medical Officer of Health.

Considerations which should determine period.

Medical officers of health, having to specify a time during which any scholars are to be excluded from attendance at any school, should have regard as far as practicable to the circumstances of the particular scholars

suffering from infectious disease or living in infected households. Not only the nature of the infection and the length of illness, but the environments of the individual as affecting the retention of infection will deserve consideration. The period of exclusion, for example, will need to be different according to the conditions of a patient's lodgment, according to the sufficiency of the separation that can be effected between a patient and excluded scholars, and according to the opportunities of effectual disinfection that can be afforded to the household. Thus a hard and fast rule, such as has been laid down in some districts where scarlatina has been present, that no child shall go to school from an infected house for three months after the disease has begun in that house, is not to be commended. It is indeed possible that under the circumstances of a particular household, a child convalescent from scarlatina or living in the same house with convalescents should not in the interests of other children be permitted to return to school until after so long a period as this; but the same ought not to be assumed of all households in the district that may be invaded by scarlatina. The better plan would be for the sanitary authority to secure, during a shorter period, the exclusion of individual sick persons and their housemates from school; and when that period is about to expire to cause fresh inquiry to be made as to the expediency of further exclusion, and, if found requisite in particular cases, to cause fresh notice to be given to the school managers.

Period of exclusion may be prolonged by new notice.

Whether exclusion or school closure to be preferred.

9. In deciding whether an outbreak of infectious disease among children of school age may be best combated by closing the school, or whether it will suffice to exclude the children of infected households, the two most important points to be considered are:—

(*a.*) The completeness and promptness of the information received by the officers of the sanitary authority respecting the occurrence of infectious cases.

(*b.*) The opportunities which exist for intercourse between the children of different households elsewhere than at school.

When exclusion system to be preferred.

10. (*a.*) The more prompt and full the knowledge of cases of infectious disease that the sanitary authority are able to obtain, the better will be the prospect of checking such disease by keeping away from school the children of infected households, and the less will be the necessity for closing schools.* If the cases be few in number, and their origin known, the exclusion from school of the children of infected households will probably suffice, but this measure will fail where there are many undiscovered or unrecognized cases, or where the known centres of infection are very numerous.

When total closure of school preferable.

Commonly, the failure of carefully considered measures of exclusion to stay the spread of an epidemic which shows a special incidence upon school children, may be regarded as pointing to the continued attendance at school of children with the prevalent disease in a mild or unrecognized form, and a strong case will appear for the closing of schools.

If by reason of the absence or exclusion of a considerable number of children, the attendance at a school be greatly reduced, it may be found better to close it altogether. This is especially apt to occur in the case of epidemics of measles, a disease which is very infectious in the early stages, before the characteristic rash has appeared, and while the symptoms resemble those of a common cold.

Closure of schools:—

in rural districts,

in populous localities,

11. (*b.*) The second material consideration, in deciding as to the desirability of closing schools during the prevalence of infectious disease, is the amount of opportunity for intercommunication between the members of different households elsewhere than at school. In sparsely populated rural districts, where the children of different households, or of separate hamlets rarely meet except at, or on their way to, the village school, the closing of the school is likely to be effectual in checking the spread of disease. It is less likely to be useful in a town or compact village (particularly where houses are sub-let and yards are in common), where the children of different households, when not at school, spend their time in playing together, and often run in and out of each other's houses. But it must be remembered that children when at play out of doors are brought into much less close association with each other than when in school.

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* Information obtainable under the Infectious Disease (Notification) Act, 1889, will be specially useful in this direction.

In rural districts, where epidemic diseases are less frequently prevalent, school closing may be required as an exceptional measure to meet an exceptional state of things. As regards more populous places, it must not be forgotten, that if schools were to be closed whenever an infectious disease was prevalent, there are many places where schools would hardly ever be open.

for purposes of disinfection, &c.,

It will sometimes be necessary to close a school for a day or two to allow of the rectification of sanitary defects of a nature to extend disease, or in order that the school may be disinfected or purified. It has happened that infectious sickness in the master's family has forbidden the attendance of scholars. These more temporary and occasional closures of schools are contemplated in the Education Code, and are to be regarded as having a real importance of their own.

where many schools exist.

12. In places where there are several public elementary schools, if an outbreak of infectious disease be confined to the scholars of one particular school, it may be sufficient to close that school only. But where different schools have all appeared to aid in the spread of disease (though perhaps to an unequal extent) the sanitary authority may consider it advisable that all should be closed lest children in an infectious state who previously attended the schools that are closed, should be sent to others that might remain open.

Sunday and private schools.

It must be remembered that sanitary authorities have no power in respect of Sunday Schools, or other private schools: except in so far as these may contravene section 91 (5), section 126, or other provision of the Public Health Act, 1875; but it will often be expedient to invite the co-operation of managers of such schools in efforts for securing the public health. Experience shows that they are usually ready to defer to the representations of the authority responsible for the public health of the district.

Duty of Medical Officer of Health as to reporting.

13. The Medical Officer of Health has not power to order the closing of a school; his function in this respect is advisory only. Reports of Medical Officers of Health to sanitary authorities, advising the closure of a school or schools in any district, are to be treated as "special" reports within the meaning of the General Order of the Local Government Board of March 23rd, 1891, and copies of them are required by Article 18 (15) and (16) of that Order to be sent to the Board, and to the County Council. These reports should state the grounds upon which the Medical Officer of Health advocates the closure of the school or schools in preference to the exclusion of particular scholars.

Grounds for action to be stated.

Notices requiring closure of schools.

14. All notices of the sanitary authority for the closing of Public Elementary Schools should be addressed in writing to the managers, and should state the grounds on which the closing is deemed necessary.

Notices to specify definite periods.

All such notices shall specify a definite time during which the school is to remain closed; this should be as short a period as can be regarded as sufficing on sanitary grounds, since a second notice may be given before the expiration of the first, if it should be found necessary to postpone the re-opening of a school. The managers of schools, after complying with the requirements of the sanitary authority, have the right of appeal to the Board of Education, if they consider any notice to be unreasonable.

W. H. POWER.

May, 1903.

P. A. No. 9.

noranda Circulars ed in 1903.

B.

(No. 1.)

Circular.

Guardians. Metropolis.

THE VACCINATION ACTS, 1867 TO 1898. RECOVERY OF PENALTIES.

Local Government Board,
Whitehall, S.W.
28th January, 1903.

SIR,

I AM directed by the Local Government Board to advert to their circular letter of the 26th of March last respecting the recovery of penalties imposed at the Metropolitan Police Courts upon defaulters under the Vaccination Acts, 1867 to 1898, and to state that the Board consider it advisable that the reports forwarded by Vaccination Officers in the Metropolis to the Chief Clerks to the Magistrates should be prepared on a uniform plan. They have, therefore, with the concurrence of the Secretary of State for the Home Department, prepared the accompanying form as a convenient one for the purpose.

The Board request that the Guardians will instruct their Vaccination Officers to use this form in any future reports which they may have to make in pursuance of the circular letter referred to above.

The Board may at the same time state that they understand that in some instances the Vaccination Officer has felt doubt whether he was not precluded by the circular letter from himself applying for a Warrant, or from paying the fee for such Warrant. I am therefore directed to state that, in the opinion of the Board, it is still competent for the Vaccination Officer to apply for a Warrant and to pay the prescribed fee, and the Secretary of State concurs in this view.

I am, Sir,

Your obedient Servant,

S. B. PROVIS,
Secretary.

The Clerk to the Guardians.

(Enclosure in No. 1.)

FINES UNDER THE VACCINATION ACTS.

MONTHLY REPORT in Cases in which the Defendant has not paid the Fine and no warrant of Distress has been applied for.

Court.	Name and Address of Defendant.	Date when fine and costs (if any) were imposed.	Reasons, if any why it would be inexpedient to enforce payment; such as receipt of certificate that the child has been vaccinated, or of illness, &c.

_____ Vaccination Officer.

_____ Date.

N.B.—This report should reach the Chief Clerk of the Police Court not later than one calendar month from the date when the fine was imposed.

(No. 2.)

Circular.
Extra-Metropolitan
Guardians.

SMALL-POX.—CASUAL PAUPERS.

Local Government Board,
Whitehall, S.W.
9th February, 1903.

SIR,

I AM directed by the Local Government Board to state that representations have been made to them on the subject of the spread of small-pox by tramps. It is urged on the Board that the present diffusion of the disease is largely due to infection conveyed from place to place by persons of the vagrant class.

The danger to the public health arising from this cause appears to the Board to be a matter of serious importance, and they think it very desirable that there should be uniformity on the part of the Boards of Guardians in dealing with it. In this connection the Board may refer to their circular letter of the 22nd January 1902, a copy of which is enclosed, and they would impress upon the Guardians the urgent necessity of securing, as far as possible, the vaccination and re-vaccination of all vagrants relieved.

The Board understand that in some cases Guardians have been in doubt as to whether they could pay for the vaccination of vagrants who failed to present themselves for subsequent inspection, and the Board direct me to state that it seems to them that in such cases payment can be made under Section 28 of the Vaccination Act, 1867 (30 & 31 Vict., c. 84), although it may not be practicable that the result of the operation should be ascertained. When the Public Vaccinator vaccinates or re-vaccinates any casual pauper, he should enter in his vaccination register the name of such pauper, and where he has not ascertained the result he should make a note in column 16 explaining the circumstances of the case.

The Board would also point out that, after the operation, the vagrant should be deemed under medical care and dieted accordingly, and he might properly be relieved from work. If necessary, he should be dealt with under Article 13 of the General Order of 18th December, 1882, as to casual paupers.

When a vagrant comes into a Casual Ward whilst under the effects of vaccination, although the operation has not been performed in the ward, he should be treated in the same way.

It appears to the Board that there would be considerable advantage if there were a systematic daily medical inspection of the inmates of Casual Wards.

The Board request that this matter may receive the immediate consideration of the Guardians, and that they will be good enough to place a copy of this circular in the hands of the Medical Officer and the Master of the Workhouse, and also of the Superintendent of the Casual Wards. Copies are enclosed for this purpose.

I am, Sir,

Your obedient Servant,

S. B. PROVIS,

Secretary.

The Clerk to the Guardians.

APP. A, No. 9

Memoranda and Circulars issued in 1903.

(No. 3.)

County Councils
and
Town Councils of
County Boroughs.

THE MIDWIVES ACT, 1902.
(2 Edw. 7, c. 17.)

Local Government Board,
Whitehall, S.W.
27th April, 1903.

SIR,

I AM directed by the Local Government Board to forward to you, for the information of the Council, the accompanying Memorandum on the subject of the Midwives Act, 1902, which has recently come into force.

The Memorandum will be placed on sale, and copies may be obtained from Messrs. Eyre & Spottiswoode, East Harding Street, Fleet Street, London, E.C., either directly or through any bookseller.

I am, Sir,
Your obedient Servant,
S. B. PROVIS,
Secretary.

To the Clerk of the County Council
or
The Town Clerk.

(Enclosure in No. 3.)

THE MIDWIVES ACT, 1902.
(2 Edw. 7, c. 17.)

MEMORANDUM.

Object of Act.

1. The object of this Act, which, except as otherwise provided, came into operation on the 1st of April, 1903, is to secure the better training and supervision of midwives by the establishment of a system of certification and enrolment of women who are properly qualified to act in that capacity.

Midwives Roll.

2. The Act accordingly makes provision for the institution of a roll which will contain the names of midwives certified under the Act, and for the formation and constitution of a body to be called the Central Midwives Board, who, as the Central Authority for carrying the Act into effect, will possess jurisdiction in regard to the issue of certificates and the admission to the roll of midwives, and will exercise a general control over the practice of such persons. (Sections 3 and 6.)

3. The Central Midwives Board has been constituted, and consists of the following members :—

W. J. Sinclair, Esq., M.D.
Miss J. Wilson.
F. H. Champneys, Esq., M.D.
J. W. Cousins, Esq., F.R.C.S.
E. P. Young, Esq., M.R.C.S., L.S.A.
C. J. Cullingworth, Esq., M.D., F.R.C.P.
J. H. Johnstone, Esq., M.P.
Miss R. Paget.
Miss D. Oldham.

Secretary, G. W. Duncan, Esq.

The temporary office of the Board is at the Privy Council Office, Whitehall, S.W.

4. The Central Midwives Board are to frame rules, subject to the approval of the Privy Council, for the purposes above referred to, and they are also required (amongst other things) to publish annually a roll of midwives who have been duly certified under the Act. (Section 3.)

Definition of Midwife.

5. The term "midwife" as used in the Act is defined by section 18 as meaning a woman who is certified under the Act, unless the context otherwise requires.

Local Supervising Authorities.

6. The local supervision of midwives is entrusted to the Council of every County or County Borough throughout England and Wales, who by section 8 are made the local supervising authority over midwives within their respective areas.

7. The same section imposes upon each local supervising authority as thus constituted various specified duties in relation to midwives. Their first duty (section 8 (7)) will be to give due notice of the effect of the Act, so far as practicable, to persons at present using the title of midwife. It is understood that the Central Midwives Board contemplate the preparation of a form of notice for the use of local authorities, which will be communicated to them, together with the rules under section 3. The Council should forthwith ascertain, so far as possible, the names and addresses of all women in the county who are accustomed to hold themselves out as midwives.

8. The other duties enjoined upon the local supervising authority by section 8, are as follows :—

(1) To exercise general supervision over all midwives practising within their area in accordance with the rules to be laid down under the Act.

(2) To investigate charges of malpractice, negligence, or misconduct, on the part of any midwife practising within their area, and should a *primâ facie* case be established, to report the same to the Central Midwives Board.

(3) To suspend any midwife from practice, in accordance with the rules under the Act, if such suspension appears necessary in order to prevent the spread of infection.

(4) To report at once to the Central Midwives Board the name of any midwife practising in their area convicted of an offence.

(5) During the month of January of each year to supply the secretary of the Central Midwives Board with the names and addresses of all midwives who, during the preceding year, have notified their intention to practise within their area, and to keep a current copy of the roll of midwives, accessible at all reasonable times for public inspection.

APP. A, No. 2.

Summaries and Circulars issued in 1902.

(6.) To report at once to the Central Midwives Board the death of any midwife or any change in the name or address of any midwife in their area, so that the necessary alteration may be made in the roll.

Delegation of powers by Local Supervising Authorities.

9. The local supervising authority may delegate, with or without any restrictions or conditions as they may think fit, any powers or duties conferred or imposed upon them by or in pursuance of the Act, to a committee appointed by them, and consisting either wholly or partly of members of the council. The provisions of sub-sections (1) and (2) of section 82 of the Local Government Act, 1888, are applied to every committee appointed under this section and to every council appointing the same, and women are made eligible to serve on any such committee. (Section 8.)

10. In addition to the general right thus conferred upon the local supervising authorities, of delegating their powers and duties under the Act to committees, the councils of counties are empowered by section 9 of the Act to delegate, with or without any restrictions or conditions as they may think fit, any powers or duties conferred or imposed upon them by or in pursuance of the Act, to any district council within the area of the county. It is provided that the powers and duties so delegated may be exercised by a committee appointed by such district council, and consisting either wholly or partly of members of the district council, and that women shall be eligible to serve on any such committee. Any expenses incurred by a district council in the execution of any powers or duties so delegated are, to an amount not exceeding such sum as may be prescribed by the county council, to be repaid to the district council as a debt by the county council, and any excess above the sum prescribed is to be borne by the district council as part of their ordinary expenses. These provisions are made applicable to the administrative county of London in like manner as if each metropolitan borough were a county district, and the borough council were the district council of that district.

Notice by Midwives.

11. Under section 10 it will be necessary for every woman who is certified as a midwife under the Act, before holding herself out as a practising midwife, or commencing to practise as a midwife in any area, to give notice in writing of her intention to do so either to the local supervising authority, or to the body to whom for the time being the powers and duties of the local supervising authority have been delegated under the Act, and she must give a like notice in the month of January in every year afterwards during which she continues to practise in the area.

12. This notice must be given to the local supervising authority of the area within which the woman in question usually resides or carries on her practice. A like notice must also be given to every other local supervising authority or delegated body within whose area the woman at any time practises or acts as a midwife, within forty-eight hours at the latest after she commences so to practise or act.

13. Every notice must contain such particulars as may be required by the rules under the Act to secure the identification of the person giving it. It will be part of the duty of the Central Midwives Board to define by the rules which that body have to frame as above mentioned the particulars thus required.

14. In order to insure proper notifications of practice by certified midwives, section 10 further provides that if any woman omits to give the notices in question or any of them, or knowingly or wilfully makes or causes or procures any other person to make any false statement in any such notice, she shall, on summary conviction, be liable to a fine not exceeding five pounds.

Prosecution of offences.

15. In addition to the other powers and duties conferred by the Act upon the local supervising authority, they are by section 13 authorised to prosecute any offences under the Act punishable on summary conviction. The offences created

by section 10 have just been referred to. Attention may also be called to the other offences under the Act which may be prosecuted by the local supervising authority. These are specified in subsections (1) and (2) of section 1 of the Act. The first of these enactments provides that from and after the 1st April, 1905, any women who not being certified under the Act shall take or use the name or title of midwife (either alone or in combination with any other word or words), or any name, title, addition, or description implying that she is certified under the Act, or is a person specially qualified to practise midwifery, or is recognised by law as a midwife, shall be liable on summary conviction to a fine not exceeding five pounds. Subsection (2) of section 1 provides that from and after 1st April, 1910, no woman shall habitually and for gain attend women in childbirth, otherwise than under the direction of a qualified medical practitioner, unless she is certified under the Act; and that any woman so acting without being certified under the Act shall be liable on summary conviction to a fine not exceeding ten pounds. But this section is not to apply to legally qualified medical practitioners, or to any one rendering assistance in the case of emergency.

Expenses and Fees.

16. Section 15 of the Act provides that any expenses under the Act payable by the council of a county or county borough shall be defrayed out of the county fund or out of the borough fund or borough rate, as the case may be.

These expenses will include not only the general expenses of the council themselves as local supervising authority in connection with the execution of their duties under the Act, and the expenses of any prosecutions which they are authorised to undertake as above-mentioned (as well as the expenses, within the prescribed limit, of any district council to whom the council of a county may have delegated their powers and duties under section 9 of the Act) but may also comprise certain sums which the council may have to pay to the Central Midwives Board under section 5 of the Act. That section makes provision for the payment of certain fees to the Central Midwives Board by women who present themselves for examination or certificates as midwives. These fees are to be devoted to the payment of expenses connected with the examination and certificate, and to the general expenses of that Board, who are required, as soon as practicable after the 31st December in each year to publish a financial statement made up to that date (which must be certified as correct by a properly qualified accountant) showing the receipts and expenditure, including their liabilities, during the year. The Central Midwives Board must then submit a copy of this statement to the Privy Council. and if the statement shows any balance against the Central Midwives Board and the balance is approved by the Privy Council, that Board are authorised to apportion that balance between the councils of the several counties and county boroughs in proportion to the number of midwives who have given notice during the year of their intention to practise in those areas respectively, and to recover from the councils the sum so apportioned.

Local Government Board,
April, 1903.

(No. 4.)

Local Government Board,
Whitehall, S.W.
25th May, 1903.

SIR,

I AM directed by the Local Government Board to state that they have received information, in connection with an outbreak of enteric fever on board the Training Ship "Cornwall," that a large quantity of blankets, lately received in this country from South Africa, have been disposed of by certain London firms to persons in various parts of the country, including the District of the Council,

Art. A, No. 8.

Memoranda and Circulars issued in 1905.

and that bacteriological examination of some of these blankets has shown that many of them, which were dirty and stained, were probably specifically infected.

The Board are advised that any such blankets suspected of being infected should be efficiently disinfected by steam, and afterwards thoroughly cleansed, preferably by washing. Where this method of treatment is not adopted, the Council should consider the expediency of securing the destruction of the implicated blankets. The destination of any of these blankets already disposed of by the consignees within the district should, if possible, be ascertained, and the purchasers warned of the suspicion attaching to the articles.

The Board desire to receive a copy of any report on this subject made to the Council by their Medical Officer of Health.

I am, Sir,

Your obedient Servant,

S. B. Provis,

Secretary

The Town Clerk, *or*
The Clerk to the Council.

No. 10.

Inspection of Public Vaccination.

LIST (alphabetically arranged) of 246 UNIONS inspected during the Year 1903, with reference to the PROCEEDINGS under the VACCINATION ACTS, 1867 to 1898, and an ACCOUNT of the AWARDS certified by the Board as payable to the respective PUBLIC VACCINATORS out of COUNTY FUNDS.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector
			£ s. d.	£ s. d.	£ s. d.	
Abergavenny	3	3	6 11 0	41 19 0	67 8 0	Dr. Mivart.
Abingdon	6	3	3 13 0	6 4 0	15 14 0	Mr. Royle.
Alston-w.-Garrigill ..	2	—		—	—	Dr. Farrar.
Amesbury	2	1	—	—	8 14 0	„ Mivart.
Anglesey	4	3	9 0 0	23 15 0	32 0 0	„ Wheaton.
Ashbourne	8	3	2 11 0	12 13 0	22 0 0	„ Johnstone.
Ashby-de-la-Zouch ..	6	5	1 13 0	19 14 0	65 5 0	„ Manby.
Axminster	11	4	1 13 0	6 17 0	17 9 0	„ Johnstone.
Aylsham	7	5	4 7 0	7 10 0	29 15 0	„ Copeman.
Bakewell	8	7	5 0 0	21 13 0	75 19 0	Dr. Johnstone
Bala	1	1	—	—	7 6 6	„ Wheaton.
Banbury	6	3	2 0 0	8 1 0	14 4 0	„ Reece.
Bangor and Beaumaris.	6	6	5 13 0	17 15 0	55 9 0	„ Wheaton.
Barnstaple	11	7	1 5 0	23 11 0	58 2 0	„ Johnstone.
Barrow-in-Furness ..	1	—	—	—	—	„ Wheaton.
Barrow-on-Soar ..	6	3	0 14 0	2 3 0	4 7 0	„ Manby.
Basford	15	8	3 10 0	57 19 0	192 19 0	„ Mair.
Bedwellty	7	5	23 7 0	33 8 0	218 13 0	„ Mivart.
Bellingham	6	—	—	—	—	„ Farrar.
Belper	9	4	9 11 0	30 8 0	74 1 0	„ Johnstone.
Bicester	7	7	0 17 0	10 10 0	23 8 0	„ Bulstrode.
Bideford	6	3	5 0 0	25 19 0	37 5 0	„ Johnstone.
Bilsdon	3	1	—	—	1 13 0	„ Manby.
Bingham	4	2	8 19 0	11 14 0	18 13 0	„ Mair.

PP. A, No. 10.

spection of accination, ed Awards to ublic Vaccinators, 1908.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Birkenhead	3	3	27 11 0	134 12 0	190 9 0	Dr. Wheaton.
Birmingham (L.A.) ..	1	1	—	—	352 4 0	„ Sweeting.
Blaby	3	1	—	—	2 14 0	„ Manby.
Blackburn	10	6	3 11 0	53 17 0	171 12 0	„ Wheaton.
Blandford	5	4	0 14 0	4 0 0	9 9 0	„ Bulstrode.
Bootle	3	1	—	—	3 18 0	„ Farrar.
Bosmere and Claydon	3	2	4 6 0	8 17 0	13 2 0	„ Copeman.
Bradfield	5	4	5 1 0	10 17 0	34 19 0	Mr. Royle.
Bradford-on-Avon ..	3	2	1 10 0	3 11 0	5 1 0	Dr. Mivart.
Bradford (Yorks) ..	10	7	3 18 0	74 17 0	204 13 0	„ Farrar.
Braintree	7	4	4 6 0	13 7 0	32 2 0	„ Fletcher.
Bramley	6	3	18 8 0	57 16 0	119 11 0	„ Farrar.
Brampton	1	1	—	—	12 13 0	Do.
Brentford	8	1	—	—	23 18 0	„ Fletcher.
Bristol	8	8	16 9 0	67 9 0	223 9 0	„ Sweeting.
Bucklow	6	6	3 13 0	48 11 0	111 10 0	„ Wheaton.
Burton-on-Trent ..	8	6	1 4 0	46 18 0	124 13 0	„ Reece.
Bury St Edmunds ..	1	—	—	—	—	„ Copeman.
Calstor	3	6	1 1 0	9 11 0	32 13 0	Dr. Manby.
Caine	1	1	—	—	8 11 0	„ Mivart.
Cambridge	3	1	—	—	12 8 0	„ Copeman.
Cannock	10	5	1 19 0	11 12 0	37 19 0	„ Reece.
Cardiff	9	8	2 10 0	168 14 0	478 3 0	„ Sweeting.
Carlisle	5	5	2 8 0	73 11 0	90 9 0	„ Farrar.
Carnarvon	7	6	4 4 0	22 4 0	80 7 0	„ Wheaton.
Castle Ward	7	1	—	—	14 18 0	„ Farrar.
Caxton and Arrington	5	4	2 11 0	6 9 0	30 12 0	„ Copeman.
Chapel-en-le-Frith ..	3	2	26 10 0	38 10 0	65 0 0	„ Johnstone.
Chelsea	1	1	—	—	87 19 0	„ Sweeting.
Chepstow	5	4	5 3 0	15 1 0	45 17 0	„ Mivart.
Chester	3	3	3 15 0	83 10 0	92 7 0	„ Wheaton.
Chesterfield	13	8	7 9 0	56 15 0	241 7 0	„ Johnstone.
Chesterton	7	6	7 12 0	12 13 0	55 8 0	„ Copeman.
Chichester	1	1	—	—	27 2 0	„ Thomson.
hippenham	6	3	1 9 0	6 17 0	13 5 0	„ Mivart.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union.		Total Sum awarded in each Union.	Medical Inspector.
			Minimum.	Maximum.		
			£ s. d.	£ s. d.	£ s. d.	
Chipping Norton ..	4	3	5 6 0	8 0 0	18 16 0	Dr. Reece.
Cockermouth	5	2	5 6 0	34 17 0	40 5 0	„ Farrar.
Colchester	1	—	—	—	—	„ Fletcher.
Congleton	3	3	9 4 0	29 6 0	56 19 0	„ Wheaton.
Conway	3	1	—	—	15 5 0	Do.
Corwen	4	3	4 9 0	9 14 0	20 7 0	Do.
Cosford	5	3	5 6 0	11 14 0	25 9 0	„ Copeman.
Crediton	11	7	1 5 0	11 3 6	31 6 0	„ Johnstone.
Cricklade and Wootton Bassett.	4	3	4 9 0	6 19 0	11 6 0	„ Mivart.
Derby	2	1	—	—	49 19 0	Dr. Johnstone.
Devizes	7	5	2 5 0	8 14 0	20 12 0	„ Mivart.
Devonport	2	—	—	—	—	„ Johnstone.
Dudley	11	9	3 0 0	51 12 0	257 4 0	„ Mivart.
Dunmow	6	5	3 15 0	7 6 0	27 16 0	„ Fletcher.
Easthampstead ..	4	4	3 6 0	15 5 0	34 3 0	Mr. Royle.
East Preston	3	3	5 1 0	41 3 0	60 18 0	Dr. Thomson.
East Retford	6	3	3 0 0	34 6 0	44 4 0	„ Mair.
East Stonehouse ..	1	1	—	—	18 0 0	„ Johnstone.
Edmonton	15	9	3 19 0	114 2 0	336 17 0	„ Fletcher.
Ely	5	5	5 18 0	30 6 0	52 1 0	„ Copeman.
Epping	8	5	2 7 0	17 0 0	44 1 0	„ Fletcher.
Erpingham	8	7	1 2 0	12 4 0	26 15 0	„ Copeman.
Exeter	1	1	—	—	72 2 0	„ Johnstone.
Farringdon	4	1	—	—	10 1 0	Mr. Royle.
Fulham	2	2	151 6 0	218 10 0	369 16 0	Dr. Fletcher.
Gainsborough	8	5	2 4 0	26 5 0	43 8 0	Dr. Manby.
George, St., East ..	1	—	—	—	—	„ Sweeting.
George's, St.	3	2	73 12 0	81 12 0	155 4 0	Do.
Giles, St., and St. George, Bloomsbury.	1	—	—	—	—	„ Fletcher.
Glanford Brigg ..	10	8	1 10 0	12 13 0	32 14 0	„ Manby.
Glossop	1	1	—	—	36 13 0	„ Johnstone.
Greenwich	2	1	—	—	118 16 0	„ Fletcher.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Halifax	10	7	0 16 0	21 7 0	61 12 0	Dr. Farrar.
Halstead	5	4	2 8 0	15 7 0	31 16 0	„ Fletcher.
Haltwhistle	4	2	0 12 0	4 6 0	4 18 0	„ Farrar.
Hammersmith ..	4	3	49 15 0	135 6 0	275 17 0	„ Fletcher.
Hampstead	1	1	—	—	70 18 0	„ Sweeting.
Hardingstone	3	2	4 0 0	7 16 0	11 16 0	„ Mair.
Hartismere	5	3	1 5 0	12 1 0	24 1 0	„ Copeman.
Haverfordwest ..	4	4	13 18 0	38 3 0	103 1 0	„ Mivart.
Hayfield	1	1	—	—	30 17 0	„ Johnstone.
Headington	2	2	7 7 0	68 18 0	76 5 0	„ Bulstrode.
Hendon	6	1	—	—	19 4 0	„ Fletcher.
Hexham	12	3	0 15 0	1 16 0	3 13 0	„ Farrar.
Hinckley	4	3	1 11 0	10 17 0	17 17 0	„ Manby.
Holbeck*	1	1	—	—	57 8 0	„ Johnstone.
Holborn	4	2	59 5 0	72 3 0	131 8 0	„ Fletcher.
Holsworthy	5	2	5 12 0	10 5 0	15 17 0	„ Johnstone.
Holyhead	3	2	11 1 0	16 13 0	27 14 0	„ Wheaton.
Honiton	13	3	1 11 0	12 12 0	23 19 0	„ Johnstone.
Hoxne	8	4	2 15 0	9 19 0	20 11 0	„ Copeman.
Hungerford and Ramsbury.	5	4	3 14 0	9 11 0	27 1 0	Mr. Royle.
Hunslet	4	4	3 14 0	84 8 0	116 3 0	Dr. Farrar.
Huntingdon	4	2	10 3 0	15 4 0	25 7 0	Do.
Ives, St.	5	3	3 3 0	10 2 0	19 15 0	Dr. Farrar.
Kensington	3	3	48 5 0	126 3 0	270 5 0	Dr. Sweeting.
Kingsbridge	7	2	6 3 0	8 12 0	14 15 0	„ Johnstone.
King's Norton	7	3	1 1 0	18 11 0	31 6 0	„ Mivart.
Knaresborough ..	3	2	8 8 0	17 17 0	26 5 0	„ Farrar.
Lancaster	5	2	3 11 0	57 5 0	60 16 0	Dr. Wheaton.
Leeds	7	6	0 19 0	70 0 0	154 6 0	„ Sweeting.
ster	2	1	—	—	22 4 0	„ Manby.
nd Winstree	10	7	2 14 0	15 7 0	44 6 0	„ Fletcher.
.. ..	6	1	—	—	28 14 0	„ Reece.

* Inspected December, 1902.

App. A. No

Inspection of Vaccination and Awards Public Vaccinators, 190

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Lincoln	[illegible]	7	1 4 0	7 10 0	35 12 0	Dr. Manby.
Linton	5	3	6 15 0	10 3 0	25 0 0	„ Copeman.
London, City of ..	3	2	7 7 0	16 16 0	24 3 0	„ Sweeting.
Longtown	2	2	2 12 0	5 11 0	8 3 0	„ Farrar.
Loughborough ..	5	5	1 6 0	13 13 0	24 9 0	„ Manby.
Lunesdale	4	3	0 6 0	4 6 0	6 6 0	„ Wheaton.
Lutterworth	6	2	7 7 0	9 13 0	16 19 0	„ Manby.
Macclesfield	6	6	4 5 0	57 9 0	95 17 0	Dr. Wheaton.
Machynlleth	4	3	2 8 0	5 7 0	12 9 0	Do.
Maidenhead	4	4	1 13 0	23 19 0	49 0 0	Mr. Royle.
Maldon	8	4	2 0 0	10 16 0	22 16 0	Dr. Fletcher.
Malmesbury	4	2	3 18 0	5 8 0	9 6 0	„ Mivart.
Mansfield	7	3	18 6 0	53 4 0	99 10 0	„ Mair.
Market Bosworth ..	6	3	1 2 0	8 2 0	17 3 0	„ Manby.
Market Harborough	6	1	—	—	2 3 0	Do.
Marlborough	2	2	3 17 0	16 0 0	19 17 0	„ Mivart.
Marylebone	2	1	—	—	171 18 0	„ Sweeting.
Melton Mowbray ..	7	5	2 12 0	15 7 0	47 9 0	„ Manby.
Mere	2	2	3 15 0	6 16 0	10 11 0	„ Mivart.
Mile End Old Town..	2	1	—	—	94 17 0	„ Sweeting.
Monmouth	6	5	1 11 0	42 17 0	70 13 0	„ Mivart.
Nantwich	7	6	3 5 0	23 4 0	44 10 0	Dr. Wheaton.
Narberth	4	4	11 6 0	16 18 0	55 1 0	„ Mivart.
Neot's, St.	6	3	2 3 0	14 18 0	21 10 0	„ Farrar.
Newark	9	6	1 4 0	9 7 0	31 2 0	„ Mair.
Newbury	3	2	7 5 0	8 11 0	15 16 0	Mr. Royle.
Newcastle-on-Tyne..	4	4	40 2 0	61 5 0	198 9 0	Dr. Sweeting.
Newmarket	8	7	2 15 0	26 16 0	78 8 0	„ Copeman.
Newport (Mon.) ..	12	11	0 18 0	97 8 0	316 3 0	„ Mivart.
Newton Abbot ..	13	9	3 12 0	28 0 0	101 1 0	„ Johnstone.
Newtown and Llanidloes.	4	3	1 15 0	17 14 0	33 18 0	„ Wheaton.
North Bierley.. ..	13	7	2 13 0	25 3 0	109 4 0	„ Farrar.
Northwich	5	5	13 19 0	32 18 0	103 8 0	„ Wheaton.

. A, No. 10.

ection of
ination,
Awards to
ic Vac-
tors, 1903.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
North Witchford ..	4	3	7 8 0	10 7 0	26 18 0	Dr. Copeman.
Norwich	1	1	—	—	142 17 0	Do.
Nottingham	6	6	21 5 0	137 15 0	457 7 0	„ Mair.
Okehampton	6	3	8 11 0	10 12 0	29 13 0	Dr. Johnstone.
Olave, St.	3	3	77 13 0	123 11 0	286 11 0	„ Sweeting.
Ormskirk	9	6	5 5 0	12 14 0	48 0 0	„ Wheaton.
Orsett	7	—	—	—	—	„ Fletcher.
Ouseburn, Great ..	4	4	4 0 0	6 4 0	20 13 0	„ Farrar.
Oxford (L.A.)	1	1	—	—	39 9 0	„ Bulstrode.
Paddington	1	2	26 1 0	211 9 0	237 10 0	Dr. Sweeting.
Pateley Bridge ..	2	2	4 8 0	17 19 0	22 7 0	„ Farrar.
Pembroke	6	5	5 18 0	27 15 0	68 3 0	„ Mivart.
Penrith	6	3	2 12 0	3 8 0	9 3 0	„ Farrar.
Pewsey	5	4	3 0 0	6 7 0	17 11 0	„ Mivart.
Plymouth (L.A.) ..	1	—	—	—	—	„ Johnstone.
Plympton St. Mary ..	5	1	—	—	9 2 0	Do.
Pontypool	6	6	9 11 0	51 13 0	168 6 0	„ Mivart.
Poplar	4	—	—	—	—	„ Fletcher.
Pwllheli	6	1	—	—	5 16 0	„ Wheaton.
Reading	1	1	—	—	41 10 0	Mr. Royle.
Ripon	4	5	1 9 0	22 1 0	32 19 0	Dr. Farrar.
Rochford	7	2	5 15 0	8 8 0	14 3 0	„ Fletcher.
Runcorn	4	4	6 5 0	45 11 0	88 5 0	„ Wheaton.
Saffron Walden ..	7	4	1 7 0	9 3 0	16 15 0	Dr. Fletcher.
Salisbury	5	5	2 5 0	24 3 0	40 16 0	„ Mivart.
Sedbergh	3	1	—	—	1 14 0	„ Farrar.
Seisdon	4	2	3 16 0	6 19 0	10 15 0	„ Reece.
Settle	7	6	1 1 0	6 8 0	21 2 0	„ Farrar.
Shaftesbury	4	3	1 19 0	8 10 0	15 9 0	„ Bulstrode.
Shardlow	9	5	3 3 0	11 5 0	39 19 0	„ Johnstone.
Shoreditch	3	2	32 13 0	77 1 0	109 14 0	„ Sweeting.
Skipton	8	4	1 9 0	6 15 0	16 4 0	„ Farrar.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Southampton (L.A.)..	2	3	58 7 0	80 7 0	138 14 0	Dr. Bulstrode.
South Molton	3	3	0 17 0	5 19 0	11 8 0	„ Johnstone.
Southwark	5	5	42 2 0	98 15 0	366 6 0	„ Fletcher.
Southwell	7	4	3 19 0	12 1 0	30 12 0	„ Mair.
Stepney	1	1	—	—	107 7 0	„ Sweeting.
Stockport	6	6	14 3 0	83 2 0	221 8 0	„ Wheaton.
Stourbridge	7	2	9 11 0	37 18 0	47 9 0	„ Mivart.
Stow	7	4	2 12 0	16 15 0	41 13 0	„ Copeman.
Strand	1	1	—	—	9 9 0	„ Sweeting.
Starminster	4	4	2 2 0	6 4 0	15 1 0	„ Bulstrode.
Swindon and Highworth.	4	—	—	—	—	„ Mivart.
Tamworth	5	3	0 12 0	33 12 0	35 19 0	Dr Reece.
Tarvin	4	4	0 7 0	10 14 0	24 7 0	„ Wheaton.
Tavistock	9	3	1 18 0	18 3 0	30 18 0	„ Johnstone.
Tendring	13	2	3 18 0	18 0 0	34 18 0	„ Fletcher.
Thingoe	8	5	1 4 0	14 14 0	37 18 0	„ Copeman.
Thomas, St.	15	9	1 4 0	27 4 0	61 12 0	„ Johnstone.
Tisbury	3	2	3 17 0	6 17 0	10 14 0	„ Mivart.
Tiverton	12	3	1 1 0	17 1 0	35 0 0	„ Johnstone
Todmorden	3	3	9 11 0	21 17 0	51 1 0	„ Farrar.
Torrington . ..	5	3	3 10 0	12 17 0	26 7 0	„ Johnstone.
Totnes	14	3	1 13 0	17 12 0	30 19 0	Do.
Toxteth Park	2	3	58 6 0	68 19 0	127 5 0	„ Sweeting.
Trowbridge and Melksham.	2	3	4 4 0	4 11 0	9 15 0	„ Mivart.
Ulverston	7	3	3 7 0	40 11 0	50 1 0	Dr. Wheaton.
Uxbridge	7	5	3 18 0	36 2 0	87 0 0	„ Fletcher.
Wakefield	6	6	10 0 0	94 6 0	345 17 0	Dr. Johnstone.
Wallingford	4	4	3 5 0	12 19 0	34 9 0	Mr. Boyle.
Walsall	6	2	37 13 0	71 17 0	109 10 0	Dr. Reece.
Wantage	6	5	3 8 0	9 7 0	30 2 0	Mr. Boyle.
Wareham & Purbeck	6	4	2 11 0	8 0 0	20 0 0	Dr. Bulstrode.

APP. A, No. 10.

Inspection of Vaccination, and Awards to Public Vaccinators, 1903.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Medical Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Warminster	5	5	1 11 0	10 0 0	21 1 0	Dr. Mivart.
Weardale	5	2	0 19 0	2 12 0	3 11 0	Mr. Royle.
Westbourne	3	3	2 8 0	10 15 0	19 13 0	Dr. Thomson.
West Bromwich ..	6	—	—	—	—	„ Reece.
Westbury and Whorwellsdown.	4	3	2 10 0	9 4 0	14 7 0	„ Mivart.
West Hampnett ..	5	5	5 17 0	16 15 0	53 8 0	„ Thomson.
Westminster	1	1	—	—	56 16 0	„ Sweeting
Wetherby .. .	6	3	3 16 0	11 1 0	25 4 0	„ Farrar.
Wharfedale	4	4	8 13 0	24 12 0	63 16 0	Do.
Whitechapel	1	1	—	—	280 2 0	„ Sweeting.
Whitehaven	6	4	17 7 0	52 2 0	116 7 0	„ Farrar.
Whittlesey	2	2	8 17 0	13 2 0	21 19 0	„ Copeman.
Wigton	7	4	3 4 0	11 12 0	22 7 0	„ Farrar.
Willesden	2	2	111 10 0	141 13 0	253 3 0	„ Fletcher.
Wilton	4	4	2 18 0	6 15 0	16 10 0	„ Mivart.
Wimborne and Cranborne.	4	2	1 9 0	8 3 0	9 12 0	„ Bulstrode.
Windsor..	3	2	26 12 0	31 16 0	58 8 0	Mr. Royle.
Wirrall	5	4	4 7 0	24 0 0	57 14 0	Dr. Wheaton.
Wisbech..	14	4	3 18 0	9 11 0	24 16 0	„ Copeman.
Witney	4	2	9 9 0	9 10 0	18 19 0	„ Farrar.
Wokingham	5	4	2 9 0	7 14 0	19 14 0	Mr. Royle.
Wolstanton and Burslem.	3	3	66 7 0	96 19 0	256 7 0	Dr. Reece.
Wolverhampton ..	6	3	40 2 0	64 3 0	158 4 0	Do.
Woodbridge	5	3	2 8 0	19 1 0	32 7 0	„ Copeman.
Woodstock	4	4	3 10 0	7 5 0	21 0 0	„ Bulstrode.
Woolwich	4	3	12 5 0	59 1 0	125 12 0	„ Sweeting.
Worksop	7	4	4 2 0	53 4 0	93 9 0	„ Mair.
Total	1,298	815	—	—	15,879 13 0	

No. 11.

STATISTICS OF THE NATIONAL VACCINE ESTABLISHMENT.

I.—EDUCATIONAL VACCINATION STATIONS, 1903.

In order to provide for the granting of those special certificates of proficiency in vaccination which are required to be part of the medical qualification for entering into contracts for the performance of public vaccination, or for acting as deputy to a contractor, the following arrangements are made :—

(1.) The vaccination stations enumerated in the subjoined list are open, under certain specified conditions, for the purposes of teaching and examination ;

(2.) The vaccinators officiating at these stations are authorised to give the required certificates of proficiency in vaccination to persons whom they have sufficiently instructed therein.

Cities and Towns having Educational Vaccination Stations.	Places used as Educational Vaccination Stations.	Vaccinators authorised to give Certificates of Proficiency in Vaccination after Instruction and Examination (*a*).	Days and Hours of Attendance of the Vaccinators at Stations where periodic Courses of Instructions are given (*b*).
London ...	St. Thomas's Hospital	Dr. Albert Ernest Cope, 26, Bessborough Gardens, S.W.	Wed., 11.
	Westminster Hospital	Dr. Albert Ernest Cope, 26, Bessborough Gardens, S.W.	Thursday, 11.
	Tolmers Square Institute, Drummond Street, N.W.	*Mr. Joseph Loane* ... 13, Great Alie Street, E.	Mon., Wed., 1
	Christ Church Mission Hall, Shroton Street, Marylebone.	Mr. Edwin Climson Greenwood, 19, St. John's Wood Park, N.W.	Friday, 3.
	St. Olave's and St. John's Institute, Tooley Street, S.E.	Mr. Victor Alexander Jaynes, 157, Jamaica Road, Bermondsey, S.E.	Wed., 3.
	Eastern Dispensary, Leman Street	Mr. Joseph Loane ... *See* above.	Wed., 11.
	New Hospital for Women, 144, Euston Road, N.W.	Miss Mary Thorne, M.D., 10, Nottingham Place, W.	Friday, 9.

(*a*) The vaccinators whose names are printed in *italic letters* are entitled to grant, after satisfactory examination, certificates of competency to persons whom they have not themselves instructed.

(*b*) Candidates for *Certificates* should communicate with the authorised teacher or examiner to learn the dates of his or her regular courses of instruction.

I.—EDUCATIONAL VACCINATION STATIONS—*continued.*

Cities and Towns having Educational Vaccination Stations.	Places used as Educational Vaccination Stations.	Vaccinators authorised to give Certificates of Proficiency in Vaccination after Instruction and Examination (*a*).	Days and Hours of Attendance of the Vaccinators at Stations where periodic Courses of Instructions are given (*b*).
Birmingham	Priory Rooms, Upper Priory.	*Dr. Edmund Robinson*... 213, Bristol Road, Edgbaston, Birmingham.	Monday, 1.30.
Bristol ...	St. Peter's Hospital, Bristol.	*Mr. George Shepley Page*, 78, Old Market Street, Bristol.	Wed., 11.
Cambridge..	Addenbrooke's Hospital.	Mr. Fredk. Deighton ... Hills Road, Cambridge.	Wed., 4.
Cardiff ...	Roath Church Institute, Sun Street, Roath.	*Mr. John Llewellyn Treharne*, 92, Newport Road, Cardiff.	Tuesday, 11
Leeds ...	Leeds General Infirmary.	Mr. A. T. Bacon ... Westfield, Hyde Park Road, Leeds.	Friday, 3.
Liverpool ...	177, Mulgrave Street	*Mr. Nathaniel Edward Roberts*, 17, Mulgrave Street, Liverpool.	Tuesday, 3.
Manchester	Southern Hospital for Women and Children, Manchester.	Dr. John Scott ... ... 249, Upper Brook Street, Manchester.	Wed., 2.
Newcastle-on-Tyne.	The Dispensary, Nelson Street.	*Dr. Frank Hawthorn* ... 6, Regent Terrace, Newcastle-on-Tyne.	Wed., 3.
Sheffield ...	Jessop Hospital for Women.	Mr. P. E. Barber ... Leavy Greave House, Hounsfield Road, Sheffield.	Monday, 3.15.
Aberdeen ...	The Public Dispensary.	*Mr. Robert Gordon McKerron*, 1, Albyn Place, Aberdeen.	Wed., 2.30.
Dundee ...	Royal Infirmary ...	Dr. Robert Cochrane Buist, 166, Nethergate, Dundee.	Thursday, 2.

(*a*) The vaccinators whose names are printed in *italic letters* are entitled to grant, after satisfactory examination, certificates of competency to persons whom they have not themselves instructed.

(*b*) Candidates for *Certificates* should communicate with the authorised teacher or examiner to learn the dates of his or her regular courses of instruction.

I.—Educational Vaccination Stations—*continued.*

Cities and Towns having Educational Vaccination Stations.	Places used as Educational Vaccination Stations.	Vaccinators authorised to give Certificates of Proficiency in Vaccination after Instruction and Examination (*a*).	Days and Hours of Attendance of the Vaccinators at Stations where periodic Courses of Instructions are given (*b*).
Edinburgh	Livingstone Dispensary, 39, Cowgate.	*Dr. John Brown Buist*, 1, Clifton Terrace, Edinburgh.	—
	The Western Dispensary, Ponton Street.	*Dr. John Brown Buist*, 1, Clifton Terrace, Edinburgh.	Thursday, 3.
	The New Town Dispensary.	Dr. Francis Cadell ... 22, Ainslie Place, Edinburgh.	Tuesday, 12.
	Marshall Street Dispensary.	Dr. Francis Cadell ... 22, Ainslie Place, Edinburgh.	Thursday, 12.
Glasgow ...	The Royal Infirmary	Mr. H. H. Borland, 571, Alexandra Parade, Dennistoun, Glasgow.	Monday, 12 (Women): Thursday, 12 (Men).
	The Western Infirmary.	Mr. John Wyllie Nicol, 7, Kersland Terrace, Glasgow.	Monday, 12.
Belfast ...	City of Belfast Union Infirmary.	Mr. John McLiesh. 49, Great Victoria Street, Belfast.	—
Dublin ...	45, Upper Sackville Street.	*Dr. Alexander Nixon Montgomery*, 45. Upper Sackville Street, Dublin.	Tues., Fri., 10.

(*a*) The vaccinators whose names are printed in *italic letters* are entitled to grant, after satisfactory examination, certificates of competency to persons whom they have not themselves instructed.

(*b*) Candidates for *Certificates* should communicate with the authorised teacher or examiner to learn the dates of his or her regular courses of instruction.

II.—Animal Vaccine Station.

The Animal Vaccine Station is at 95, Lamb's Conduit Street, where Mr. T. S. Stott and Dr. Leslie Thorne Thorne attend for the Vaccination of Children on Tuesdays and Thursdays, at 10.30 a.m.

III.—Distribution of Glycerinated Calf Lymph, 1903.

Number of applications from Public Vaccinators ...	78,817
Supplies sent out :—	
Charged capillary tubes	795,707

No. 12.

APP. A, No. 12.

On the Operations of the Animal Vaccine Establishment 1903-04; by Mr. Stott.

REPORT on the OPERATIONS of the ANIMAL VACCINE ESTABLISHMENT at LAMB'S CONDUIT STREET, during the year 1903–04; by Mr. THOMAS S. STOTT, Director.

During the year April 1st, 1903, to March 31st, 1904, 157 calves were vaccinated. The aggregate weight on reception at Lamb's Conduit Street, of the 157 calves was 41,137 lbs. On dismissal from the station their aggregate weight was 42,346 lbs., so that during their retention for vaccination purposes they gained in weight by an average of 7·7 lbs.

Of the above calves 140 were vaccinated direct from other calves, and 17 were vaccinated from calf lymph which had been stored. As usual, vaccinations performed with direct lymph proved to be more successful than the others.

Insertions to the number of 5,864 in calf-to-calf operations produced 5,729 vesicles; in the 17 calves vaccinated from lymph stored in tubes, 688 insertions produced 544 vesicles, giving rates of insertion success respectively of 97·69 and 79·06 per cent.

But slight difference in the results of calf-to-calf vaccinations was observed, whether the lymph used was from calves vaccinated 96 hours, or from calves vaccinated 120 hours previously; in either case the rate of insertion success was practically 98 per cent.

During the year 1903–1904 there were performed 1,510 primary vaccinations, five separate insertions of lymph being made in each instance. Of the persons thus vaccinated 772 were males and 738 were females.

All but 73 of the primary vaccinations succeeded at the first attempt.

There were 73 primary vaccinations performed from calf-to-arm; of these persons primarily vaccinated by the several staff operators 64 on examination were found to have taken in five places, 6 in four, and 3 in three places. The aggregate insertion success was therefore 96·71 per cent.

During the same period 1,437 primary vaccinations were performed with glycerinated calf lymph. Of these, 13 failed to return for inspection, and of the remaining 1,424, on examination 941 were found to have taken in five places, 159 in four, 114 in three, 65 in two places, 72 in one place, and 73 failed at the first attempt.

The insertion success was therefore 82·65 per cent.

There were but 4 cases brought back after inspection on account of some abnormal condition following their vaccination, and these were of a trivial character.

No. 13.

REPORT on the OPERATIONS of the GLYCERINATED CALF LYMPH ESTABLISHMENT, 1903-04; by Dr. FRANK R. BLAXALL.

During the year small-pox almost disappeared from London, but continued to manifest itself in a mild way in various towns in the provinces. In consequence of this subsidence the issue of lymph has been less than that of the previous year.

The amount of glycerinated calf lymph despatched during the year ending March 31st, 1904, was equivalent to 691,540 capillary tubes, each containing sufficient lymph for one vaccination.

Particulars of the despatch are shown in Table I. This quantity was not all issued in single charges, but some was sent out in small tubes containing sufficient lymph for 10, 25, 50, or 100 vaccinations.

The results of the use of the lymph during the year for the 640,463 cases of which report has been sent in show 98·3 per cent. case success and 93·5 per cent. insertion success.

The primary vaccinations numbered 531,997, giving a case success of 98·4 per cent. and an insertion success of 93·5 per cent. The re-vaccinations numbered 108,466, giving a case success of 97·4 per cent. and an insertion success of 93·4 per cent.

Table II. shows these results set out quarterly.

The lymph thus issued was derived from 508 calves.

All these animals, after slaughter, were examined by our veterinary surgeon and certified to be healthy.

One other calf, which appeared to be in health during the course of vaccination, was found at the autopsy to exhibit evidence of tubercular lesions. None of the lymph from this calf was issued.

The bacteriological examinations of the lymph have been carried out as heretofore, and further observations have been made by Dr. Alan Green on chloroformed vaccine lymph. His report on this subject will be found in Appendix C.

TABLE II.

Showing results of the use of GLYCERINATED CALF LYMPH issued during the year ended 31st March, 1904.

TOTAL CASES.

Period during which sent out.	Number of cases used for.	Percentage success.	
		Case.	Insertion.
June Quarter 1903	192,900	97·8	92·5
September „ „	162,654	98·1	92·9
December „ „	129,618	98·5	94·0
March „ 1904	155,291	98·8	94·8
Total	640,463	98·3	93·5

PRIMARY CASES.

Period during which sent out.	Number of cases used for.	Percentage success.	
		Case.	Insertion.
June Quarter 1903	144,666	98·1	92·6
September „ „	138,547	98·2	92·9
December „ „	115,127	98·6	93·9
March „ 1904	133,657	98·9	94·8
Total	531,997	98·4	93·5

RE-VACCINATIONS.

Period during which sent out.	Number of cases used for.	Percentage success.	
		Case.	Insertion.
June Quarter 1903	48,234	97·0	92·1
September „ „	24,107	97·3	93·5
December „ „	14,491	97·8	95·0
March „ 1904	21,634	98·1	94·8
Total	108,466	97·4	93·4

SI[illegible]ATIONAL VACCINE ESTABLISHMENT

in single charges.

t out Quarterly. represented in Single Charges.

ber		mg. 10 ns.	mg. 25 ns.	mg. 50 ns.	mg. 100 n.

No. 14.

DIGEST of the VACCINATION OFFICERS' RETURNS with regard to Children whose Births were registered in the Year 1902.

The following is a summary of the thirtieth annual return under the Vaccination Act, 1871 :—Of 940,509 births returned to the Board by the several vaccination officers in England and Wales as registered during the year 1902, the number which, at the time the return was made, had been registered as successfully vaccinated was 703,721 (being 74·8 per cent. of the whole), and the number registered as having died unvaccinated was 90,826 (or 9·7 per cent. of the whole). Of the remaining 145,962 children, 3,027 (or 0·3 per cent. of the whole) had been registered as insusceptible of vaccination ; 27 as having contracted small-pox ; 12,213 (or 1·3 per cent.) as having their vaccination postponed by medical certificate ; and 33,759 (or 3·6 per cent.) in respect of whom certificates of conscientious objection were received ; leaving 96,936 (or 10·3 per cent.) as "removed," "not to be traced," or otherwise unaccounted for. If from the 940,509 births returned by these officers deduction be first made of the deaths that took place before vaccination, it appears that, of the surviving 849,683 children, there were registered at the time of the return 82·8 per cent. as successfully vaccinated ; 0·4 per cent. as either insusceptible of vaccination, or as having had small-pox ; 1·4 per cent. as under medical certificate of postponement ; and 4·0 per cent. in respect of whom certificates of conscientious objection to vaccination had been obtained ; leaving 11·4 per cent. as at that time still unaccounted for as regards vaccination.

The proportion of cases unaccounted for in the metropolitan returns for 1902 is 21·3 per cent. ; in the provincial returns 10·0. Of the registered births of the thirty-one years, 1872–1902, the

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proportion not finally accounted for in regard to vaccination (including cases postponed) in each year respectively has been as follows :—

—	Metropolis.	Rest of England.	—	Metropolis.	Rest of England.
1872	8·8	4·5	1888	10·3	8·2
1873	8·7	4·2	1889	11·8	9·6
1874	8·8	4·1	1890	13·9	10·9
1875	9·3	3·8	1891	16·4	12·9
1876	8·5	4·0	1892	18·4	14·3
1877	7·1	4·1	1893	18·2	15·7
1878	7·1	4·3	1894	20·6	19·0
1879	7·8	4·5	1895	24·9	19·8
1880	7·0	4·5	1896	26·4	22·3
1881	5·7	4·3	1897	29·1	21·6
1882	5·6	4·5	1898	33·0	19·6
1883	6·5	4·9	1899	27·7	15·4
1884	6·8	5·3	1900	25·8	14·9
1885	7·0	5·5	1901	24·1	11·2
1886	7·8	6·1	1902	21·3	10·0
1887	9·0	6·7			

In 1902 the proportion of cases unaccounted for (excluding the postponed cases) in the Metropolis and in the rest of England was 20·3 and 8·7 per cent. respectively.

VACCINATION OFFICERS' RETURNS, 1902.

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—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
ENGLAND & WALES	940,509	703,731	3,027	27	33,759	90,826	12,213	96,936
Ditto (excluding Metropolitan Unions).	809,994	615,033	2,598	17	32,725	78,280	10,946	70,405
METROPOLITAN UNIONS	130,515	88,698	429	10	[illegible]	12,546	[illegible]	26,531
REGISTRATION DIVISIONS.								
London	130,515	88,698	[illegible]	10	1,034	12,546	1,267	26,531
South Eastern	81,385	65,901	328	—	2,766	6,505	1,088	4,797
South Midland	58,140	40,398	187	6	5,419	4,766	647	6,717
Eastern	54,259	38,072	147	—	2,207	4,575	732	7,626
South Western	44,848	34,943	88	—	2,409	3,590	943	2,860
West Midland	111,196	85,511	382	—	3,395	11,100	1,709	9,099
North Midland	60,909	36,126	95	—	6,612	5,603	869	10,604
North Western	156,663	124,039	583	5	4,056	16,429	1,390	[illegible]
York	103,785	78,949	486	1	3,443	10,537	1,187	9,182
Northern	72,660	55,721	248	1	1,818	7,451	1,218	6,203
Welsh†	66,154	54,458	104	4	600	[illegible]	1,164	3,106
REGISTRATION COUNTIES								
ENGLAND:								
Bedford	4,109	1,741	2	—	990	343	4	1,029
Berks	6,826	5,181	18	—	155	537	85	830
Buckingham	4,470	3,173	8	—	695	329	56	229
Cambridge	4,870	4,205	11	—	109	348	45	152
Chester	21,500	18,443	81	—	140	1,942	208	686
Cornwall	7,339	5,824	12	—	194	684	164	461
Cumberland	7,470	5,788	6	—	341	694	152	489
Derby	15,086	8,837	10	—	729	[illegible]	243	3,745
Devon	15,672	13,165	31	—	189	1,349	276	663
Dorset	4,015	3,816	8	—	163	317	83	228
Durham	43,672	33,123	155	1	1,044	4,636	726	3,987
Essex	32,948	22,731	110	—	588	2,690	[illegible]	6,283
Gloucester	16,767	10,787	93	—	1,607	1,587	488	2,255
Hereford	2,631	2,248	1	—	42	220	[illegible]	[illegible]
Hertford	7,207	5,698	15	—	370	485	87	552
Huntingdon	1,119	993	[illegible]	—	22	81	9	10
Kent (extra-metropolitan).	24,210	20,332	142	—	621	1,955	273	887
Lancaster	135,163	105,596	452	5	3,916	14,487	1,182	9,525
Leicester	12,875	3,597	[illegible]	—	3,378	1,470	249	4,172

* The figures in this co[illegible] reference to the other columns
Monmouth is included in the

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	—
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
74·8	3·6	11·6	15·2	788,248	ENGLAND & WALES.
75·9	4·0	10·0	14·0	689,078	Ditto (excluding Metropolitan Unions).
68·0	[illegible]	21·3	22·1	99,170	METROPOLITAN UNIONS.
					REGISTRATION DIVISIONS.
68·0	0·8	21·3	22·1	99,170	London.
81·0	3·4	7·2	10·6	71,889	South Eastern.
69·5	9·3	12·7	22·0	45,157	South Midland.
71·8	4·1	15·4	19·5	42,898	Eastern.
77·9	5·4	8·5	13·9	37,974	South Western.
76·9	3·1	9·7	12·8	95,011	West Midland.
59·3	10·8	18·8	29·6	47,000	North Midland.
79·2	[illegible]	7·4	10·0	143,122	North Western.
76·1	3·3	10·0	13·3	87,850	York.
76·7	2·5	10·2	12·7	61,720	Northern.
83·3	0·9	6·5	7·4	57,259	Welsh.
					REGISTRATION COUNTIES.
					ENGLAND:
42·4	24·1	25·1	49·2	1,858	Bedford.
75·9	2·3	13·4	15·7	5,937	Berks.
71·0	15·5	5·9	21·4	3,296	Buckingham.
80·3	2·2	4·0	6·2	4,587	Cambridge.
85·8	0·7	4·2	4·9	19,949	Chester.
79·4	2·6	8·5	11·1	6,268	Cornwall.
77·5	4·6	8·6	13·2	6,413	Cumberland.
58·6	4·8	26·4	31·2	11,046	Derby.
84·0	1·2	6·0	7·2	13,902	Devon.
82·7	3·5	6·7	10·2	4,953	Dorset.
75·8	2·4	[illegible]	13·2	36,555	Durham.
69·0	1·8	20·7	22·5	26,042	[illegible].
64·3	9·6	16·4	26·0	12,501	Gloucester.
85·5	1·6	4·6	6·2	2,366	Hereford.
79·1	5·1	8·9	14·0	5,925	Hertford.
88·7	2·0	1·7	3·7	979	Huntingdon.
84·0	2·8	4·8	7·4	21,790	Kent (extra-metropolitan).
78·1	2·9	7·9	[illegible]	123,173	Lancaster.
[illegible]	26·2	34·3	60·5	6,098	Leicester.

[illegible] the table, which strictly refer to the births registered in 1902.
[illegible] Registration Division.

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—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
REGISTRATION COUNTIES—*cont.*								
ENGLAND—*cont.*								
Lincoln	13,281	9,949	28	—	1,997	1,316	136	455
Middlesex (extra-metropolitan).	22,875	16,716	119	6	288	1,999	253	3,521
Monmouth	11,459	8,747	14	1	427	1,108	387	775
Norfolk	11,948	8,694	25	—	1,264	1,137	79	749
Northampton	9,101	4,414	18	—	2,595	839	178	1,057
Northumberland ..	20,106	15,546	83	—	415	2,031	320	1,713
Nottingham	19,215	13,340	43	—	1,090	2,275	241	2,226
Oxford	4,389	3,459	10	—	370	363	35	164
Rutland	453	403	3	—	20	20	—	6
Salop	6,806	6,000	20	—	70	540	71	135
Somerset	10,779	8,054	27	—	787	795	259	857
Southampton	19,336	16,455	59	—	334	1,549	197	742
Stafford	37,328	20,231	85	—	541	3,982	540	2,949
Suffolk	9,363	7,547	12	—	355	748	107	594
Surrey (extra-metropolitan).	17,459	14,103	72	—	417	1,400	281	1,183
Sussex	13,554	9,830	37	—	1,239	1,044	249	1,155
Warwick	27,485	20,561	104	—	798	3,006	317	2,699
Westmorland	1,410	1,264	4	—	18	90	20	14
Wilts	6,438	4,069	10	—	1,076	453	160	651
Worcester	20,069	16,624	79	—	337	1,815	251	963
York, E. Riding ..	13,477	11,220	54	—	152	1,242	98	711
York, N. Riding ..	11,156	8,459	30	—	410	1,149	216	892
York, W. Riding ..	79,152	59,270	402	1	2,881	8,146	873	7,579
WALES:								
Anglesey	882	793	—	—	1	79	3	6
Brecknock	1,618	1,345	1	—	12	155	49	56
Cardigan	1,345	1,166	2	—	12	129	20	16
Carmarthen	4,023	3,413	1	—	4	447	129	29
Carnarvon	3,483	3,044	5	—	5	365	21	43
Denbigh	3,103	2,746	2	1	8	287	29	30
Flint	2,505	2,184	3	—	2	197	53	66
Glamorgan	31,786	30,046	62	2	122	3,404	381	1,769
Merioneth	1,681	1,481	1	—	3	142	29	25
Montgomery	1,557	1,325	2	—	1	132	28	69
Pembroke	3,180	1,880	10	—	2	219	32	37
Radnor	532	288	1	—	1	54	3	185

* The figures in this column have no reference to the other columns

1902—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					REGISTRATION COUNTIES—*cont.*
					ENGLAND—*cont.*
74·9	10·5	4·4	14·9	10,909	Lincoln.
73·1	1·2	16·5	17·7	18,631	Middlesex (extra-metropolitan).
76·3	3·7	10·1	13·8	8,701	Monmouth.
72·6	10·0	6·9	17·5	9,137	Norfolk.
46·5	26·5	15·6	42·1	6,050	Northampton.
77·5	2·1	10·1	12·2	17,437	Northumberland.
69·4	5·7	12·8	18·5	18,690	Nottingham
78·8	8·4	4·5	12·9	3,631	Oxford.
89·2	4·4	1·3	5·7	344	Rutland.
87·9	1·0	3·0	4·0	6,256	Salop.
74·7	7·3	10·4	17·7	8,555	Somerset
85·1	1·7	4·9	6·6	17,563	Southampton.
79·3	1·4	9·3	10·7	31,940	Stafford.
80·6	—	7·5	11·3	7,737	Suffolk.
80·8	2·4	8·4	10·8	16,453	Surrey (extra-metropolitan).
72·5	9·1	10·4	19·5	10,448	Sussex.
74·8	2·9	11·0	13·9	23,712	Warwick.
89·6	1·3	3·4	3·7	1,315	Westmorland.
63·5	16·7	12·6	29·3	4,206	Wilts.
83·8	1·7	6·1	7·8	18,250	Worcester.
93·3	1·1	6·0	7·1	11,640	York, E. Riding.
76·8	3·7	9·9	13·6	9,441	York, N. Riding.
74·9	3·6	10·7	14·3	66,769	York, W. Riding.
					WALES:
89·9	0·1	1·0	1·1	937	Anglesey.
89·1	0·7	6·5	7·3	1,415	Brecknock.
96·7	0·9	2·7	3·6	1,326	Cardigan.
—	0·1	3·9	4·0	3,529	Carmarthen.
97·4	0·1	1·8	1·9	3,230	Carnarvon
88·5	0·3	1·9	2·2	3,715	Denbigh.
97·2	0·1	4·8	4·9	2,300	Flint.
81·9	0·4	—	7·2	26,156	Glamorgan
96·1	0·3	3·2	3·4	1,416	Merioneth.
96·1	0·1	6·2	6·3	1,900	Montgomery.
96·2	0·1	3·2	3·3	2,002	Pembroke.
54·1	—	35·3	35·5	342	Radnor.

In the table, which strictly refer to the births registered in 1902.

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RETURNS.

METROPOLITAN UNIONS.	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
Bermondsey	4,243	3,047	12	—	18	439	8	719
Bethnal Green	4,505	2,029	6	—	12	487	2	1,969
Camberwell	7,370	5,131	22	—	47	635	113	1,422
Chelsea	1,043	1,235	14	—	21	150	29	194
Fulham	4,729	3,7 0	19	—	49	451	51	459
George, St., Hanover Square.	2,323	1,949	11	—	13	214	14	122
George, St., in the East	2,158	1,333	1	—	2	183	—	639
Giles, St., and St. George	983	614	5	—	1	98	—	265
Greenwich	5,567	4,361	17	—	46	567	24	552
Hackney	7,406	4,650	33	—	58	791	88	1,786
Hammersmith	3,141	2,540	9	—	56	297	23	216
Hampstead	1,517	1,255	18	—	27	104	11	102
Holborn	4,284	2,801	1	—	18	486	76	902
Islington	9,455	6,593	39	1	73	818	98	1,433
Kensington	3,411	2,836	19	—	23	311	20	202
Lambeth	8,912	6,280	21	—	89	796	43	1,683
Lewisham	3,653	2,851	12	—	61	297	9	422
London, City of	338	267	1	—	3	32	1	34
Marylebone, St.	3,890	3,061	18	—	15	325	136	335
Mile End Old Town ..	4,478	1,391	3	3	11	448	—	2,622
Paddington	3,262	2,629	12	—	19	291	35	276
Pancras, St.	6,329	4,015	27	3	45	626	141	1,470
Poplar	5,790	2,569	11	—	19	647	12	2,532
Shoreditch	3,993	2,054	5	—	12	482	56	1,384
Southwark	6,771	4,211	24	1	34	815	26	1,660
Stepney	1,879	965	8	—	5	207	4	690
Strand	279	205	—	—	1	21	11	41
Wandsworth and Clapham.	11,167	7,997	37	—	156	985	210	1,782
Westminster	642	513	1	—	6	42	3	77
Whitechapel	2,864	2,390	1	—	6	200	9	258
Woolwich	3,934	3,226	22	2	88	299	14	283
	130,515	88,698	429	10	1,034	12,546	1,267	26,531

* The figures in this column have no reference to the other columns

1902—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	METROPOLITAN UNIONS.
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
71·8	0·4	17·1	17·5	3,933	Bermondsey.
45·1	0·3	43·8	44·1	2,452	Bethnal Green.
69·8	0·6	29·8	30·4	5,127	Camberwell.
75·2	1·3	13·6	14·9	1,313	Chelsea.
78·2	1·0	10·8	11·8	3,830	Fulham.
83·9	0·6	5·9	7·5	1,983	George, St., Hanover Square.
61·8	0·1	29·6	29·7	1,903	George, St., in the East.
62·5	0·1	27·0	27·1	716	Giles, St., and St. George.
78·3	0·8	10·8	11·1	4,678	Greenwich
62·8	0·8	35·3	36·1	6,096	Hackney.
60·9	1·8	7·6	9·4	2,844	Hammersmith.
83·7	1·8	7·4	9·2	1,261	Hampstead.
65·4	0·4	22·8	23·2	3,861	Holborn.
72·8	0·8	16·9	17·7	7,357	Islington.
83·1	0·7	6·5	7·2	3,155	Kensington.
70·5	1·0	19·4	20·4	6,902	Lambeth.
78·1	1·7	11·8	13·5	3,042	Lewisham.
79·0	0·9	10·4	11·3	385	London, City of.
78·7	0·4	12·1	12·5	3,456	Marylebone, St.
31·1	0·2	68·6	68·8	1,547	Mile End Old Town.
80·6	0·6	9·5	10·1	2,723	Paddington.
63·4	0·7	25·6	26·3	4,539	Pancras, St.
44·4	0·3	43·9	44·2	2,811	Poplar.
51·5	0·3	36·1	36·4	2,337	Shoreditch.
69·2	0·5	34·9	35·4	4,857	Southwark.
51·4	0·3	36·9	37·2	1,089	Stepney.
75·5	0·4	18·6	19·0	218	Strand.
71·6	1·4	17·8	19·2	9,351	Wandsworth and Clapham.
79·9	0·9	12·5	13·4	484	Westminster
88·6	0·2	9·3	9·5	2,852	Whitechapel
83·0	2·2	7·5	9·7	3,451	Woolwich.
68·0	0·8	21·3	22·1	99,170	

In the table, which strictly refer to the births registered in 1902.

—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
BEDFORD.								
Ampthill	466	344	—	—	75	25	2	52
Bedford	1,239	332	—	—	13	97	—	807
Biggleswade	686	509	1	—	102	56	1	17
Leighton Buzzard ..	410	244	1	—	128	24	1	12
Luton	1,276	322	—	—	672	141	—	141
	4,109	1,741	2	—	990	343	4	1,029
BERKS.								
Abingdon	405	351	2	—	5	28	4	15
Bradfield	426	357	—	—	3	34	9	23
Easthampstead	334	286	3	—	1	19	5	10
Faringdon..	311	266	1	—	7	18	4	15
Hungerford and Ramsbury.	367	319	—	—	8	29	2	9
Maidenhead	615	496	1	—	43	45	7	23
Newbury	450	403	2	—	15	16	5	9
Reading	1,888	944	4	—	41	233	10	657
Wallingford	317	283	—	—	6	16	6	6
Wantage	349	290	—	—	5	32	12	10
Windsor	974	831	4	—	17	63	15	44
Wokingham	390	345	1	—	4	25	6	9
	6,826	5,181	18	—	155	567	85	830
BUCKINGHAM.								
Amersham	578	438	1	—	73	33	5	28
Aylesbury..	578	447	2	—	60	53	11	5
Buckingham	233	192	1	—	21	14	—	5
Eton..	908	791	3	—	16	57	4	37
Newport Pagnell ..	720	516	—	—	129	54	7	14
Winslow	148	94	—	—	42	10	1	1
Wycombe	1,305	695	1	—	354	108	8	139
	4,470	3,173	8	—	695	329	36	229
CAMBRIDGE.								
Cambridge	840	675	3	—	29	72	14	47
Caxton and Arrington	173	158	1	—	—	12	—	2
Chesterton	742	645	—	—	22	48	9	18
Ely	494	439	—	—	18	24	4	9
Linton	254	235	1	—	—	12	4	2
Newmarket	837	732	1	—	6	59	12	27
North Witchford ..	444	384	1	—	22	34	1	2
Whittlesey	238	208	1	—	—	16	—	13
Wisbech	848	729	3	—	12	71	1	32
	4,870	4,205	11	—	109	348	45	152

* The figures in this column have no reference to the other columns

1902—*continued.*

PERCENTAGES of BIRTHS registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	—
Successfully vaccinated.	Exempted by "Conscientious Objection" Certificates.	Not finally accounted for, including cases postponed.	Unvaccinated.		
(1.)	(2.)	(3.)	(Cols. 2 & 3.)		
					BEDFORD.
60·1	15·1	10·8	25·9	325	Ampthill.
26·0	1·0	65·1	66·1	466	Bedford.
74·2	14·9	2·6	17·5	462	Biggleswade.
59·5	31·2	3·2	34·4	240	Leighton Buzzard.
25·2	52·7	11·1	63·8	365	Luton.
42·4	24·1	25·1	49·2	1,858	
					BERKS.
86·7	1·2	4·7	5·9	392	Abingdon.
83·8	0·7	7·5	8·2	363	Bradfield.
88·6	0·3	4·5	4·8	315	Easthampstead.
85·5	2·3	6·1	8·4	270	Faringdon.
86·9	2·2	3·0	5·2	311	Hungerford and Ramsbury.
80·7	7·0	4·9	11·9	495	Maidenhead
89·6	3·3	3·1	6·4	407	Newbury.
50·0	2·2	35·3	38·5	1,534	Reading.
89·3	1·9	3·8	5·7	278	Wallingford.
83·1	1·4	6·3	7·7	331	Wantage.
85·3	1·8	6·1	7·9	812	Windsor.
88·5	1·0	3·8	4·8	429	Wokingham.
75·9	2·3	13·4	15·7	5,937	
					BUCKINGHAM.
75·8	12·6	5·7	18·3	376	Amersham.
77·3	10·4	2·8	13·2	514	Aylesbury.
83·4	9·0	2·1	11·1	201	Buckingham.
87·1	1·8	4·5	6·3	853	Eton.
71·7	17·9	2·9	20·8	544	Newport Pagnell.
63·5	28·4	1·4	29·8	100	Winslow.
53·3	27·1	11·3	38·4	702	Wycombe.
71·0	15·5	5·9	21·4	3,290	
					CAMBRIDGE.
80·4	3·5	7·3	10·8	882	Cambridge.
91·3	—	1·2	1·2	161	Caxton and Arrington
88·9	3·0	3·6	6·6	717	Chesterton.
88·9	3·6	2·6	6·2	442	Ely.
92·5	—	2·4	2·4	216	Linton.
87·5	0·7	4·7	5·4	805	Newmarket.
86·5	5·0	0·7	5·7	412	North Witchford.
87·4	—	5·5	5·5	212	Whittlesey.
86·0	1·4	3·9	5·3	740	Wisbech.
86·3	2·2	4·0	6·2	4,587	

in the table, which strictly refer to the births registered in 1902.

	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox. *	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
CHESTER.								
Birkenhead	5,263	4,575	23	—	5	471	14	168
Bucklow	1,923	1,737	21	—	9	116	16	23
Chester	1,434	1,261	6	—	1	122	21	33
Congleton	878	741	—	—	7	75	20	35
Macclesfield	1,295	1,154	3	—	6	93	18	21
Nantwich	2,238	1,809	15	—	32	209	23	150
Northwich	1,647	1,497	2	—	7	126	5	10
Runcorn	1,191	1,058	1	—	12	101	12	7
Stockport	4,043	3,181	4	—	80	526	53	219
Tarvin	367	350	3	—	1	26	3	2
Wirral	1,212	1,090	4	—	—	75	23	20
	21,500	18,443	81	—	140	1,942	208	686
CORNWALL.								
Austell, St.	860	743	3	—	16	71	7	20
Bodmin	391	339	—	—	2	25	1	24
Camelford	179	151	—	—	4	18	4	2
Columb Major, St. ..	332	282	—	—	4	25	9	12
Falmouth	544	407	—	—	43	52	14	28
Germans, St.	472	415	—	—	—	35	12	10
Helston	479	341	—	—	5	61	26	46
Launceston	311	269	—	—	12	24	1	5
Liskeard	568	443	2	—	32	39	15	37
Penzance	1,122	906	3	—	20	92	13	88
Redruth	1,173	802	1	—	12	175	37	146
Stratton	146	105	—	—	—	7	1	33
Truro	772	621	3	—	44	60	24	20
	7,339	5,824	12	—	194	684	164	461
CUMBERLAND.								
Alston-with-Garrigill ..	72	54	—	—	7	9	2	—
Bootle	483	422	—	—	4	45	8	4
Brampton	169	141	—	—	3	13	7	5
Carlisle	1,617	1,445	—	—	8	130	20	14
Cockermouth	2,156	1,151	1	—	245	243	97	419
Longtown	129	113	—	—	3	10	2	1
Penrith	510	469	1	—	10	26	1	3
Whitehaven	1,775	1,531	2	—	41	157	12	32
Wigton	559	462	2	—	20	61	3	11
	7,470	5,788	6	—	341	694	152	489
DERBY.								
Ashbourne	541	387	1	—	19	52	11	71
Bakewell	882	702	1	—	52	55	23	49
Belper	2,140	1,381	—	—	191	214	52	299
Chapel-en-le-Frith ..	719	627	1	—	2	46	7	36
Chesterfield	5,053	3,072	5	—	80	564	92	1,240
Derby	3,277	856	1	—	224	374	1	1,821
Glossop	529	359	1	—	90	37	31	11
Hayfield	357	290	—	—	4	40	—	23
Shardlow	1,588	1,160	—	—	67	140	26	195
	15,086	8,837	10	—	729	1,522	243	3,745

* The figures in this column have no reference to the other columns

1902 —*continued.*

PERCENTAGES of BIRTHS registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	—
Successfully vaccinated.	Exempted by "Conscientious Objection" Certificates.	Not finally accounted for, including cases postponed.	Unvaccinated.		
(1.)	(2.)	(3.)	(Cols. 2 & 3.)		
					CHESTER.
87·1	0·1	3·4	3·5	4,888	Birkenhead.
90·4	0·5	2·0	2·5	1,362	Bucklow.
87·2	0·1	3·8	3·9	1,449	Chester.
84·4	0·8	6·8	7·1	838	Congleton.
89·1	0·5	3·0	3·5	1,210	Macclesfield.
80·8	1·4	7·7	9·1	1,992	Nantwich
90·9	0·4	0·9	1·3	1,534	Northwich.
88·8	1·0	1·6	2·6	1,100	Runcorn.
78·6	1·5	6·7	8·2	5,709	Stockport.
90·4	0·3	1·3	1·6	348	Tarvin.
89·9	—	5·5	5·5	1,246	Wirral.
85·8	0·7	4·2	4·9	19,949	
					CORNWALL.
86·4	1·9	3·1	5·0	768	Austell, St.
89·7	0·5	6·4	6·9	392	Bodmin.
94·4	2·2	3·4	5·6	153	Camelford.
85·0	1·3	6·3	7·5	341	Columb Major, St.
74·8	7·9	7·7	15·6	495	Falmouth.
87·9	—	4·7	4·7	431	Germans, St.
71·2	1·0	15·0	16·0	410	Helston.
86·5	3·9	1·9	5·8	247	Launceston.
79·4	6·7	7·5	13·2	403	Liskeard.
80·8	1·8	9·0	10·8	949	Penzance.
88·4	1·0	15·6	16·6	919	Redruth.
71·9	—	28·3	28·3	116	Stratton.
80·4	5·7	5·7	11·4	644	Truro.
79·4	2·6	6·5	12·1	6,268	
					CUMBERLAND.
75·0	9·7	2·8	12·5	62	Alston-with-Garrigill.
87·4	0·8	2·6	3·3	495	Bootle.
83·5	1·8	7·1	8·9	160	Brampton.
89·4	0·5	2·1	2·6	1,623	Carlisle.
53·4	11·4	23·9	35·3	1,486	Cockermouth.
87·0	3·5	3·3	4·6	126	Longtown.
92·0	2·0	0·8	2·8	496	Penrith.
96·3	2·3	2·5	4·8	1,499	Whitehaven.
82·6	3·0	2·5	6·1	516	Wigton.
77·5	4·6	8·6	13·2	6,413	
					DERBY
71·6	2·5	15·3	18·7	439	Ashbourne.
79·6	5·9	8·2	14·1	713	Bakewell.
64·7	8·8	16·4	25·3	1,449	Belper.
87·2	0·3	6·0	6·3	607	Chapel-en-le-Frith
60·8	1·6	26·4	28·0	3,435	Chesterfield.
35·1	6·8	55·6	62·4	1,317	Derby.
67·9	17·0	7·9	24·9	497	Glossop.
81·2	1·1	6·4	7·5	335	Hayfield.
73·0	4·2	13·9	18·1	2,174	Shardlow.
58·6	4·8	26·4	31·2	11,046	

in the table, which strictly refer to the births registered in 1902.

PP. A, No. 14.

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RETURNS,

	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
DEVON.								
Axminster	316	284	1	—	10	19	—	2
Barnstaple	921	769	—	—	41	75	15	21
Bideford	543	454	2	—	15	46	24	2
Crediton	330	300	—	—	—	30	—	—
Devonport	2,068	1,596	5	—	2	185	81	219
East Stonehouse ..	429	363	1	—	—	38	2	26
Exeter	794	635	1	—	8	95	21	34
Holsworthy	202	180	—	—	1	16	5	—
Honiton	463	425	—	—	2	32	2	2
Kingsbridge	350	314	1	—	3	23	3	7
Newton Abbot	1,554	1,344	5	—	28	128	20	29
Okehampton	374	319	1	—	4	34	9	7
Plymouth	2,964	2,315	9	—	24	352	50	214
Plympton St. Mary ..	460	391	—	—	3	26	7	33
South Molton	288	265	—	—	1	19	—	3
Tavistock	565	512	—	—	13	36	1	3
Thomas, St.	1,199	1,045	3	—	13	75	23	40
Tiverton	610	555	—	—	6	34	5	10
Torrington	299	260	—	—	5	27	3	4
Totnes	923	839	2	—	10	58	6	8
	15,672	13,165	31	—	189	1,348	276	663
DORSET.								
Beaminster	228	204	—	—	1	20	1	2
Blandford	257	220	—	—	6	14	1	16
Bridport	261	229	2	—	1	22	1	6
Cerne	118	103	—	—	4	6	3	2
Dorchester	382	352	1	—	3	18	1	27
Poole	946	709	2	—	60	79	46	50
Shaftesbury	270	228	—	—	4	22	6	10
Sherborne	254	222	—	—	3	11	2	16
Sturminster	199	169	—	—	8	10	4	8
Wareham and Purbeck	338	306	1	—	9	19	—	3
Weymouth	961	758	1	—	59	60	11	75
Wimborne and Cranborne.	398	336	1	—	5	36	7	13
	4,615	3,816	8	—	163	317	83	228
DURHAM.								
Auckland	3,351	2,456	8	—	307	343	60	177
Chester-le-Street ..	2,409	1,975	8	—	35	274	29	88
Darlington	1,692	1,274	7	—	91	168	16	136
Durham	2,534	2,030	19	1	89	263	45	87
Easington	2,136	1,822	3	—	15	230	17	49
Gateshead	6,760	4,202	12	—	195	726	78	1,547
Hartlepool	3,207	2,752	14	—	19	281	47	94
Houghton-le-Spring ..	1,623	1,351	11	—	—	181	15	65
Lanchester	3,048	2,331	14	—	114	359	87	143
Sedgefield	771	666	1	—	9	81	3	11
South Shields	6,230	4,629	18	—	39	670	122	752
Stockton	2,201	1,796	9	—	45	223	30	98
Sunderland	6,700	5,008	30	—	40	747	160	715
Teesdale	576	488	1	—	16	47	10	14
Weardale	434	343	—	—	30	43	7	11
	43,672	33,123	155	1	1,044	4,636	726	3,967

* The figures in this column have no reference to the other columns

1902—*continued.*

PERCENTAGES of BIRTHS registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903	
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					DEVON.
89·9	3·2	0·6	3·8	318	Axminster.
83·5	4·5	3·9	8·4	805	Barnstaple.
83·6	3·8	4·6	7·6	412	Bideford.
90·9	—	0·0	0·0	310	Crediton.
78·4	0·1	14·4	14·5	1,751	Devonport.
84·6	—	6·3	6·3	370	East Stonehouse.
90·0	1·0	6·9	7·9	761	Exeter.
89·1	0·5	2·5	3·0	202	Holsworthy.
91·6	0·4	0·9	1·3	333	Honiton.
89·7	0·9	2·6	3·5	334	Kingsbridge.
89·5	1·8	3·2	5·0	1,310	Newton Abbot.
85·3	1·1	4·3	5·4	821	Okehampton.
78·1	0·8	8·9	9·7	3,712	Plymouth.
85·0	0·7	8·7	9·4	427	Plympton St. Mary.
92·0	0·3	1·0	1·3	264	South Molton.
90·6	2·5	0·7	3·0	489	Tavistock.
87·2	1·1	5·3	6·4	1,110	Thomas, St.
91·0	1·3	2·5	3·6	571	Tiverton.
87·0	1·7	2·3	4·0	345	Torrington.
90·9	1·1	1·6	2·6	887	Totnes.
84·0	1·2	6·0	7·2	13,903	
					DORSET.
89·5	0·4	1·3	1·7	226	Beaminster.
85·6	2·6	6·6	6·9	256	Blandford.
97·7	0·4	2·7	3·1	227	Bridport.
87·3	3·4	4·3	7·6	88	Cerne.
90·9	0·8	7·3	8·1	377	Dorchester.
74·9	6·3	10·1	16·4	705	Poole.
84·4	1·5	5·9	7·4	258	Shaftesbury.
97·4	1·2	7·1	8·3	243	Sherborne.
84·9	4·0	6·0	10·0	185	Sturminster.
90·5	2·7	0·9	3·6	333	Wareham and Purbeck.
78·6	6·1	8·9	15·0	395	Weymouth.
81·4	1·3	5·0	6·3	353	Wimborne and Cranborne.
82·7	3·5	6·7	10·2	4,063	
					DURHAM
73·3	9·2	7·1	16·3	2,513	Auckland.
83·0	1·5	4·9	6·4	2,038	Chester-le-Street.
75·3	5·4	9·0	14·4	1,886	Darlington.
80·1	3·5	5·2	8·7	2,068	Durham.
85·3	0·7	3·1	3·8	1,382	Easington.
69·2	2·9	24·0	26·9	5,296	Gateshead.
85·8	0·6	4·4	5·0	3,143	Hartlepool.
83·2	—	4·9	4·9	1,411	Houghton-le-Spring.
76·5	3·7	7·5	11·2	2,556	Lanchester.
86·4	1·2	1·8	3·0	552	Sedgefield.
74·3	0·8	14·0	14·8	4,978	South Shields.
81·6	2·0	5·8	7·8	1,961	Stockton.
74·7	0·6	13·1	13·7	5,500	Sunderland.
81·7	2·8	4·2	7·0	515	Teesdale.
79·0	8·9	4·1	11·0	375	Weardale.
76·8	2·4	10·8	13·2	30,566	

In the table, which strictly refer to the births registered in 1902,

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rns, 1902.

RETURNS,

—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining
ESSEX.								
Billericay	466	406	1	—	4	27	3	25
Braintree	539	457	3	—	10	24	29	8
Chelmsford	814	739	—	—	8	42	6	19
Colchester	943	698	1	—	12	59	8	175
Dunmow	316	287	—	—	3	17	2	7
Epping	710	636	2	—	11	43	2	26
Halstead	343	278	—	—	25	29	5	6
Lexden and Winstree .	470	434	—	—	7	30	2	7
Maldon	558	479	2	—	22	37	1	17
Ongar	234	197	1	—	1	16	5	14
Orsett	1,045	772	4	—	57	111	31	70
Rochford	1,505	968	2	—	138	115	43	239
Romford	3,154	2,589	19	—	32	232	8	269
Saffron Walden ..	332	286	—	—	1	32	2	11
Tendring	1,152	957	3	—	22	81	5	84
West Ham	20,376	12,578	74	—	229	1,795	394	5,306
	32,948	22,731	110	—	588	2,690	546	6,283
GLOUCESTER								
Barton Regis . ..	397	304	2	—	6	31	34	20
Bristol	9,193	6,051	79		191	905	206	1,671
Cheltenham	1,129	702	4	—	206	112	6	99
Chipping Sodbury ..	455	349	1	—	8	43	5	49
Cirencester	448	384	—	—	13	34	6	11
Dursley	237	161	1	—	40	17	5	13
Gloucester	1,585	692	2	—	524	155	80	132
Newent	206	173	—	—	15	12	—	6
Northleach	203	171	—	—	10	18	—	4
Stow-on-the-Wold ..	211	179	—	—	11	15	3	3
Stroud	778	402	2	—	141	58	18	157
Tetbury	147	108	—	—	24	13	—	2
Tewkesbury	342	189	1	—	61	36	—	55
Thornbury	381	332	—	—	7	20	9	13
Westbury-on-Severn ..	696	346	1	—	280	45	6	12
Wheatenhurst	140	84	—	—	23	6	20	7
Winchcomb ..	219	160	—	—	41	17	—	1
	16,767	10,787	93	—	1,607	1,537	488	2,255
HEREFORD.								
Bromyard	223	193	—	—	—	19	5	6
Dore	185	154		—	11	12	5	3
Hereford	824	701	—	—	12	66	22	23
Kington	242	203	—	—	2	27	3	7
Ledbury	309	254	—	—	7	27	2	19
Leominster	321	281	—	—	3	29	3	6
Ross	363	312	1	—	7	29	3	11
Weobley	164	150	—	—	—	11	—	3
	2,031	2,248	1	—	42	220	42	78

* The figures in this column have no reference to the other columns

1902—*continued.*

PERCENTAGES of BIRTHS registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	—
Successfully vaccinated.	Exempted by "Conscientious Objection" Certificates.	Not finally accounted for, including cases postponed.	Unvaccinated.		
(1.)	(2.)	(3.)	(Cols. 2 & 3.)		
					ESSEX.
87·1	0·9	8·0	0·9	450	Billericay.
88·2	1·9	7·0	8·9	509	Braintree.
90·8	1·0	3·1	4·1	794	Chelmsford.
73·0	1·3	19·4	20·7	937	Colchester.
90·8	0·9	2·3	3·7	505	Dunmow.
88·2	1·8	3·9	5·6	615	Epping.
81·0	7·3	3·2	10·6	397	Halstead.
90·2	1·6	1·9	3·4	419	Lexden and Winstree.
85·8	3·9	3·2	7·1	573	Maldon.
84·2	0·4	8·1	8·5	182	Ongar.
75·9	6·5	9·7	15·2	837	Orsett.
54·3	9·2	18·7	27·9	993	Rochford.
82·1	1·2	6·8	10·0	5,138	Romford.
86·1	0·3	3·9	4·2	288	Saffron Walden.
83·1	1·9	7·7	9·6	1,164	Tendring.
61·7	1·1	28·0	29·1	14,551	West Ham.
69·0	1·8	20·7	22·5	26,042	
					GLOUCESTER.
76·6	1·5	13·0	15·1	368	Barton Regis.
65·8	2·1	21·4	23·5	6,752	Bristol.
62·3	10·2	9·3	27·5	965	Cheltenham.
76·7	1·8	11·9	13·7	431	Chipping Sodbury.
85·7	2·9	3·8	6·7	356	Cirencester.
67·9	16·9	7·6	24·5	170	Dursley.
48·7	33·1	13·4	46·5	1,030	Gloucester.
84·0	7·3	2·9	10·2	124	Newent.
84·2	4·9	2·0	6·9	187	Northleach.
84·8	5·2	2·8	8·0	185	Stow-on-the-Wold.
51·7	18·1	22·5	40·6	480	Stroud.
73·5	16·3	1·4	17·7	106	Tetbury.
56·3	17·9	16·1	34·0	381	Tewkesbury.
87·1	1·8	5·8	7·6	391	Thornbury.
49·7	41·1	2·6	43·7	330	Westbury-on-Severn.
80·0	16·4	19·3	35·7	97	Wheatenhurst.
73·1	18·7	0·5	19·2	176	Winchcomb.
64·5	9·6	16·4	26·0	12,501	
					HEREFORD.
86·5	—	4·9	4·9	221	Bromyard.
83·2	6·0	4·8	10·3	158	Dore.
85·1	1·5	5·5	7·0	723	Hereford.
83·9	0·8	4·1	4·9	211	Kington.
82·2	3·5	6·8	9·1	240	Ledbury.
87·5	0·9	3·5	3·4	301	Leominster.
89·0	1·9	3·9	5·8	378	Ross.
91·5	—	1·8	1·8	134	Weobley.
85·5	1·8	4·6	6·2	2,366	

in the table, which strictly refer to the births registered in 1902.

A, No. 14.

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—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed	Remaining.
HERTFORD.								
Albans, St.	750	474	—	—	147	41	—	97
Barnet	1,493	1,169	6	—	25	110	19	148
Berkhampstead ..	348	297	—	—	31	27	11	12
Bishop Stortford ..	494	438	—	—	6	27	12	21
Buntingford	114	106	—	—	—	5	—	3
Hatfield	188	164	1	—	—	12	3	6
Hemel Hempstead ..	401	298	—	—	55	23	8	16
Hertford	987	836	—	—	8	28	3	14
Hitchin	714	620	3	—	19	50	7	15
Royston	315	294	—	—	4	17	2	6
Ware	538	469	1	—	9	28	10	21
Watford	1,405	1,037	3	—	65	114	15	161
Welwyn	63	56	1	—	1	1	—	4
	7,207	5,898	15	—	370	485	87	552
HUNTINGDON.								
Huntingdon	477	421	1	—	11	34	6	4
Ives, St.	334	301	2	—	4	23	1	3
Neots, St.	308	271	1	—	7	24	2	3
	1,119	993	4	—	22	81	9	10
KENT (EXTRA-METROPOLITAN).								
Ashford, East	314	274	1	—	9	18	3	9
Ashford, West	430	397	1	—	30	37	10	24
Bleau	562	464	5	—	10	47	5	23
Bridge	284	247	4	—	—	19	3	11
Bromley	2,077	1,805	24	—	25	149	10	64
Canterbury	452	377	5	—	4	37	3	26
Cranbrook	256	223	2	—	7	20	2	1
Dartford	3,009	2,595	32	—	45	228	19	90
Dover	1,331	1,174	4	—	12	101	5	35
Eastry	771	685	3	—	11	54	1	17
Elham	1,234	1,082	6	—	32	101	26	47
Faversham	714	633	4	—	5	56	1	15
Gravesend and Milton	702	571	5	—	11	65	13	36
Hollingbourn	325	284	—	—	3	21	3	14
Hoo	110	90	1	—	—	11	1	4
Maidstone	1,180	962	3	—	30	86	11	54
Malling	801	703	3	—	13	61	3	18
Medway	2,808	2,368	7	—	68	287	19	61
Milton	826	703	—	—	8	73	7	35
Romney Marsh	151	135	1	—	1	8	—	6
Sevenoaks	846	647	6	—	10	38	11	34
Sheppey	566	478	3	—	3	65	8	9
Strood	1,257	1,064	5	—	27	107	19	35
Tenterden	200	169	—	—	9	10	4	9
Thanet, Isle of	1,602	1,261	6	—	95	148	27	65
Tonbridge	1,538	1,093	6	—	105	118	56	160
	21,210	20,332	142	—	621	1,955	273	887

* The figures in this column have no reference to the other columns

1902—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1905.	—
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					HERTFORD.
62·5	19·4	12·8	32·2	602	Albans, St.
78·8	1·7	11·3	13·0	1,211	Barnet.
76·7	8·9	6·6	15·5	289	Berkhampstead.
86·6	1·2	0·7	7·9	486	Bishop Stortford.
93 0		2·6	2·6	121	Buntingford.
86·2		4·8	4·8	181	Hatfield.
74·8	13·7	6·2	19·9	336	Hemel Hempstead.
86·8	2·1	4·4	6·5	383	Hertford.
86 8	2·7	3·1	5·8	646	Hitchin.
90·2	1·3	3·2	4·5	320	Royston.
87·2	1·7	6·1	7·8	451	Ware.
73·1	4·6	14·0	18·6	848	Watford.
88·9	1·6	6·3	7·9	59	Welwyn.
79·1	5·1	8·9	14·0	5,935	
					HUNTINGDON.
88·3	2·3	2·1	4·4	403	Huntingdon.
90·1	1·2	1·2	2·4	290	Ives, St.
88·0	2·5	1·6	3·9	286	Neots, St.
88·7	2·0	1·7	3·7	979	
					KENT (EXTRA-METROPOLITAN).
87·3	2·9	3·8	6·7	315	Ashford, East.
81·2	6·1	7·0	13·1	415	Ashford, West.
92·6	1·8	6·4	8·2	496	Blean.
87·0	—	4·9	4·9	264	Bridge.
86·9	1·2	3·6	4·8	1,895	Bromley.
83·4	0·9	6·4	7·3	443	Canterbury.
87·5	2·8	1·2	4·0	227	Cranbrook.
86·2	1·5	3·6	5·1	2,715	Dartford.
88·2	0·9	2·0	2·9	1,205	Dover.
92·8	1·4	2·3	3·7	650	Eastry.
82·8	2·6	5·9	8·5	1,110	Elham.
90·6	0·7	2·2	[redacted]	635	Faversham.
81·5	1·6	7·0	8·6	907	Gravesend and Milton.
87·4	0·9	5·2	6·1	265	Hollingbourn.
85·3		4·3	4·3	89	Hoo.
81·5	6·6	3·8	10·6	966	Maidstone.
87·8	1·6	2·8	4·2	741	Malling.
84·3	2·4	2·8	5·2	2,708	Medway.
85·1	1·0	5·1	6·1	730	Milton.
89·4	0·7	4·0	4·7	162	Romney Marsh.
84·7	1·6	7·0	8·6	622	Sevenoaks.
94·5	0·5	3·0	3·5	482	Sheppey.
84·6	2·1	4·3	6·4	1,067	Strood.
84·0	4·5	6·5	11·0	193	Tenterden.
78·7	5·2	5·7	11·6	1,198	Thanet, Isle of.
71·1	6·8	14·0	20·8	1,208	Tonbridge.
84·0	2·6	4·8	7·4	21,790	

in the table, which strictly refer to the births registered in 1902.

—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
LANCASTER.								
Ashton under-Lyne ..	4,764	3,323	4	—	198	380	54	706
Barrow-in-Furness ..	1,934	1,708	6	—	6	174	3	21
Barton-upon-Irwell ..	3,074	2,406	11	—	15	304	114	234
Blackburn	5,737	4,800	32	—	183	585	35	125
Bolton	7,408	6,657	15	—	52	611	14	59
Burnley	5,390	2,738	27	1	894	634	120	226
Bury	3,508	2,918	7	—	409	327	29	218
Chorley	1,786	1,568	3	—	5	188	9	32
Chorlton	10,395	7,489	31	—	30	1,120	68	1,657
Clitheroe	493	396	—	—	5	41	16	25
Fylde, The	3,569	2,090	10	—	72	253	49	104
Garstang	285	264	—	—	2	13	3	4
Haslingden	2,706	2,189	8	—	184	247	24	54
Lancaster	1,767	1,434	2	—	13	191	24	101
Leigh	3,064	2,648	4	—	14	292	9	97
Liverpool	5,203	4,278	38	3	—	678	9	209
Lunesdale	167	151	—	—	2	13	1	—
Manchester	4,494	3,394	5	—	4	561	97	533
Oldham	5,762	2,954	6	—	1,220	706	9	840
Ormskirk	2,540	2,183	26	—	11	243	16	67
Prescot	5,420	4,674	16	—	11	547	26	147
Preston	4,233	3,190	11	—	19	572	10	428
Prestwich	6,437	5,306	19	—	62	806	25	429
Rochdale	2,838	2,051	3	—	323	277	36	148
Salford	7,897	6,323	16	—	38	921	104	505
Todmorden	893	686	—	—	81	83	12	31
Toxteth Park ..	4,289	3,315	30	—	3	512	56	373
Ulverston	1,100	989	—	—	4	83	6	13
Warrington	3,578	3,010	24	—	11	388	34	111
West Derby	18,312	15,084	91	1	6	1,890	94	1,146
Wigan	7,339	6,069	9	—	38	885	77	259
	135,163	106,596	452	6	3,916	14,487	1,182	9,525
LEICESTER.								
Ashby de-la-Zouch ..	1,548	774	—	—	270	174	—	350
Barrow-on-Soar ..	667	276	1	—	277	74	7	32
Billesdon	105	77	—	—	10	8	—	10
Blaby	642	158	1	—	386	46	6	43
Hinckley	759	308	—	—	329	68	—	47
Leicester	6,315	623	7	—	1,128	684	161	3,512
Loughborough	995	335	—	—	405	85	66	74
Lutterworth	251	188	1	—	31	13	4	11
Market Bosworth ..	629	301	1	—	255	39	—	33
Market Harborough ..	418	231	—	—	148	29	7	9
Melton Mowbray ..	583	346	—	—	157	48	4	28
	12,875	3,597	11	—	3,376	1,470	249	4,172
LINCOLN.								
Boston	1,101	840	4	—	119	104	9	25
Bourne	428	322	1	—	11	47	3	44
Caistor	407	308	1	—	69	24	1	4
Gainsborough	1,001	587	—	—	251	94	3	66
Glanford Brigg	1,586	818	1	—	354	161	13	39
Grantham	817	691	6	—	30	74	8	18

* The figures in this column have no reference to the other columns

PERCENTAGES of BIRTHS registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					LANCASTER.
69·7	4·2	13·6	17·8	4,311	Ashton-under-Lyne.
88·8	0·5	1·2	1·7	1,793	Barrow-in-Furness.
78·3	0·5	11·0	11·5	3,498	Barton-upon-Irwell.
83·7	3·2	2·6	6·0	5,225	Blackburn.
89·9	0·7	1·0	1·7	6,799	Bolton.
51·7	16·6	19·6	36·2	2,583	Burnley.
70·1	12·4	7·5	19·9	2,868	Bury.
67·8	0·3	2·3	2·6	1,720	Chorley.
72·1	0·3	16·6	16·9	8,948	Chorlton.
82·4	1·0	8·1	9·1	419	Clitheroe.
78·7	2·8	8·3	11·1	2,278	Fylde, The.
92·6	0·7	2·1	2·8	275	Garstang.
80·9	8·6	2·0	9·7	2,404	Haslingden.
81·3	0·7	7·1	7·8	1,657	Lancaster.
86·4	0·6	3·5	4·0	3,845	Leigh.
62·2	—	4·2	4·2	4,974	Liverpool.
90·4	1·2	0·6	1·8	168	Lunesdale.
75·3	0·1	14·1	14·2	5,583	Manchester.
51·3	31·5	14·8	36·3	4,869	Oldham.
35·7	0·4	3·5	3·7	2,266	Ormskirk.
66·2	0·2	3·2	3·4	5,214	Prescot.
75·4	0·5	10·3	10·8	4,380	Preston.
82·4	0[illegible]	7·1	7·9	5,891	Prestwich.
72·3	11·4	6·5	17·9	3,012	Rochdale.
80·1	0·4	7·7	8·1	7,371	Salford.
77·0	9·1	3·7	12·8	964	Todmorden.
77·3	0·1	10·0	10·1	4,360	Toxteth Park.
89·9	0·4	1·7	2·1	1,048	Ulverston.
84·1	0·3	4·1	4·4	4,168	Warrington.
82·5	0·0	6·6	6·8	17,280	West Derby.
83·0	0·5	4·3	4·8	6,841	Wigan.
78·1	2·9	7·9	10·8	125,173	
					LEICESTER.
50·0	16·1	22·6	38·7	961	Ashby-de-la-Zouch.
36·4	41·5	8·6	50·3	643	Barrow-on-Soar.
73·3	[illegible]	9·6	19·0	102	Billesdon.
24·6	60·1	7·6	67·7	274	Blaby
41·0	43·8	6·2	50·0	271	Hinckley.
9·9	17·9	58·2	76·1	2,170	Leicester.
34·7	42·8	14·5	56·5	454	Loughborough.
74·9	13·4	7·2	19·6	220	Lutterworth.
47·9	40·5	5·3	45·7	286	Market Bosworth.
55·3	35·4	2·4	37·8	337	Market Harborough.
59·3	26·9	5·5	32·4	370	Melton Mowbray.
27·9	26·2	34·3	60·5	6,098	
					LINCOLN.
70·3	10·6	3·1	13·9	872	Boston.
75·2	2·6	11·0	13·6	380	Bourne.
76·7	17·0	1·2	18·2	206	Caistor.
66·6	[illegible]	6·9	32·0	906	Gainsborough.
69·9	26·6	3·6	29·4	766	Glanford Brigg.
[illegible]	5·7	3·2	6·9	736	Grantham.

In the table, which strictly refer to the births registered in 1902.

	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
LINCOLN—*cont.*								
Grimsby	2,547	1,968	4	—	95	313	49	118
Holbeach	477	349	1	—	85	37	2	3
Horncastle	439	370	—	—	4	33	1	31
Lincoln	1,863	1,432	3	—	156	193	24	54
Louth	638	515	—	—	46	44	17	16
Sleaford	623	512	1	—	37	68	3	2
Spalding	560	373	1	—	128	47	2	9
Spilsby	579	527	4	—	1	40	1	6
Stamford	416	347	1	—	11	37	—	20
	13,281	9,949	28	—	1,397	1,316	136	455
MIDDLESEX (EXTRA-METROPOLITAN).								
Brentford	5,360	4,124	27	—	27	523	32	627
Edmonton	10,052	6,826	48	5	117	849	160	2,056
Hendon	1,474	1,267	13	—	51	91	7	45
Staines	658	815	—	—	3	77	5	58
Uxbridge	1,198	1,012	3	—	11	102	6	62
Willesden	3,835	2,672	28	1	59	356	43	676
	22,875	16,716	119	6	268	1,989	253	3,524
MONMOUTH.								
Abergavenny	712	556	4	—	43	79	1	30
Bedwellty	3,640	2,697	2	—	44	403	135	359
Chepstow	551	411	—	1	73	43	3	20
Monmouth	825	587	1	—	130	68	8	31
Newport	4,002	3,192	7	—	102	372	168	161
Pontypool	1,729	1,304	—	—	36	143	72	174
	11,459	8,747	14	1	427	1,108	387	775
NORFOLK.								
Aylsham	428	381	—	—	8	35	3	1
Blofield	290	249	1	—	9	23	4	5
Depwade	537	462	2	—	18	37	3	15
Docking	415	364	—	—	10	27	—	14
Downham	403	351	3	—	1	37	1	10
Erpingham	626	475	3	—	43	58	12	35
Faith, St.	306	217	—	—	38	31	7	13
Flegg, East and West ..	259	237	—	—	3	18	—	1
Forehoe	256	212	—	—	12	23	7	2
Freebridge Lynn ..	261	220	—	—	5	22	1	13
Henstead	262	233	—	—	7	19	—	3
King's Lynn	535	70	—	—	33	49	—	383
Loddon and Clavering	292	263	—	—	8	18	1	2
Mitford and Launditch	675	474	1	—	11	54	13	22
Norwich	3,142	1,707	6	—	884	383	4	159
Smallburgh	459	370	—	—	33	45	3	8
Swaffham	223	185	—	—	4	12	10	12
Thetford	500	432	—	—	26	33	1	8
Walsingham	479	385	1	—	37	39	5	12
Wayland	311	254	—	—	14	35	—	8
Yarmouth, Great ..	1,389	1,153	8	—	60	141	4	23
	11,948	8,694	25	—	1,264	1,137	79	749

* The figures in this column have no reference to the other column

1902—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	
Successfully vaccinated.	Exempted by "Conscientious Objection" Certificates.	Not finally accounted for, including cases postponed.	Unvaccinated.		
(1.)	(2.)	(3.)	(Cols. 2 & 3.)		
				*	LINCOLN—*cont.*
77·3	3·7	6·6	10·3	2,440	Grimsby.
73·2	17·8	1·0	18·8	360	Holbeach.
84·5	0·9	7·3	8·2	382	Horncastle.
76·9	8·4	4·2	12·[illegible]	1,522	Lincoln.
80·7	7·2	5·2	12·4	522	Louth.
82·2	[illegible]·9	0·8	8·7	529	Sleaford.
66·6	22·9	2·0	24·9	367	Spalding.
91·0	0·2	1·2	1·4	488	Spilsby.
83·4	2·8	4·8	7·4	354	Stamford.
74·9	10·6	4·4	14·9	10,892	
					MIDDLESEX (EXTRA-METROPOLITAN).
76·9	0·5	12·3	12·8	4,442	Brentford.
67·9	1·2	22·0	23·2	7,880	Edmonton.
86·0	3·5	3·5	7·0	1,352	Hendon.
85·1	0·3	6·6	6·9	933	Staines.
84·6	0·9	5·7	6·6	1,084	Uxbridge.
69·7	1·5	18·7	20·2	3,136	Willesden.
73·1	1·2	16·5	17·7	18,831	
					MONMOUTH
78·1	5·6	4·4	[illegible]·3	577	Abergavenny.
74·1	1·2	13·6	14·8	2,844	Bedwellty.
74·6	13·2	4·2	17·4	495	Chepstow.
71·3	15·8	4·7	20·5	614	Monmouth
79·8	2·6	8·2	10·8	3,127	Newport.
75·4	2·1	14·2	16·3	1,044	Pontypool.
76·3	3·7	10·1	13·8	8,701	
					NORFOLK.
89·0	1·9	0·9	2·8	397	Aylsham.
85·9	3·1	3·1	6·2	269	Blofield.
86·0	3·4	3·4	6·[illegible]	472	Depwade.
87·7	2·4	3·4	5·8	394	Docking.
87·1	0·3	2·7	3·0	386	Downham.
75·9	6·9	7·5	14·4	450	Erpingham.
70·9	12·4	6·5	18·9	259	Faith, St.
91·5	1·2	0·4	1·6	266	Flegg, East and West.
82·8	4·7	3·5	8·2	305	Forehoe.
84·3	1·9	5·4	7·3	242	Freebridge Lynn.
88·9	2·7	1·1	3·8	261	Henstead.
13·1	6·2	71·6	77·8	84	King's Lynn.
90·1	2·7	1·0	3·7	262	Loddon and Clavering.
82·4	1·9	6·1	8·0	446	Mitford and Launditch.
[illegible]	28·1	5·2	33·3	1,796	Norwich.
80·6	7·2	2·4	9·6	344	Smallburgh
83·0	1·8	9·9	11·7	192	Swaffham.
86·4	5·2	1·8	7·0	400	Thetford.
80·4	7·7	3·5	[illegible]·2	434	Walsingham.
81·7	4·5	2·6	7·1	281	Wayland.
88·0	4·3	1·9	6·2	1,187	Yarmouth, Great.
72·8	10·6	6·9	17·5	9,127	

in the table, which strictly refer to the births registered in 1902.

1902—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1902.	—
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					NORTHAMPTON.
67·1	9·6	12·5	23·1	206	Brackley.
71·2	13·1	7·3	20·4	222	Brixworth.
70·9	15·4	6·8	21·2	303	Daventry.
60·5	29·1	4·7	33·8	189	Hardingstone.
24·1	67·1	29·6	66·7	805	Kettering.
30·4	44·5	11·6	56·0	1,183	Northampton.
68·6	5·5	2·0	5·5	190	Oundle.
78·1	2·5	10·8	13·3	1,135	Peterborough.
66·9	21·8	5·1	26·9	262	Potterspury.
49·7	38·9	3·0	41·9	238	Thrapston.
59·5	33·6	10·5	34·1	176	Towcester.
43·2	33·6	15·1	48·7	1,147	Wellingborough.
48·5	28·5	13·6	42·1	6,056	
					NORTHUMBERLAND.
87·2	1·1	3·8	4·9	538	Alnwick.
91·3	—	2·4	2·4	124	Belford.
88·2	5·1	4·4	7·6	110	Bellingham.
84·0	—	5·7	5·7	447	Berwick-upon-Tweed.
51·8	3·0	37·1	40·1	991	Castle Ward
89·0	1·1	1·7	2·8	186	Glendale.
61·3	28·0	4·9	32·9	177	Haltwhistle.
74·9	9·5	7·0	17·4	761	Hexham.
72·6	0·9	14·7	15·6	1,961	Morpeth.
78·4	1·3	9·8	11·0	6,794	Newcastle-on-Tyne.
87·9	—	1·7	1·7	141	Rothbury.
80·3	1·5	6·5	8·0	5,217	Tynemouth.
77·3	2·1	10·1	12·2	17,437	
					NOTTINGHAM.
66·6	8·3	12·6	20·9	3,951	Basford.
83·9	6·5	2·2	8·5	286	Bingham.
84·1	4·8	3·7	8·6	538	East Retford
56·8	2·4	26·0	30·4	3,742	Mansfield.
85·0	2·8	3·6	5·4	232	Newark.
71·0	6·6	9·3	16·1	7,863	Nottingham.
82·3	5·0	4·9	7·9	406	Southwell.
80·6	2·7	6·6	9·5	1,202	Worksop.
69·4	5·7	13·8	18·5	16,620	
					OXFORD.
68·6	26·5	7·5	34·0	617	Banbury.
80·6	5·4	5·4	10·8	211	Bicester.
69·8	16·3	6·4	24·7	298	Chipping Norton.
94·3	1·0	4·3	5·3	755	Headington.
84·2	6·0	2·6	8·6	535	Henley.
87·6	0·5	4·3	4·7	480	Oxford.
89·0	6·3	0·7	7·0	278	Thame.
82·1	6·5	2·8	9·3	264	Witney.
82·0	7·9	3·8	11·5	295	Woodstock.
78·8	8·4	4·5	12·9	3,631	

In the table, which strictly refer to the births registered in 1902.

—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
RUTLAND.								
Oakham	239	219	3	—	1	14	—	2
Uppingham	213	184	—	—	19	6	—	4
	452	403	3	—	20	20	—	6
SALOP.								
Atcham	1,205	1,052	5	—	7	100	10	31
Bridgnorth	362	319	1	—	6	27	5	4
Church Stretton ..	118	106	—	—	2	10	—	—
Cleobury Mortimer ..	255	222	—	—	3	19	1	10
Clun	221	180	—	—	8	20	6	7
Drayton	370	314	—	—	1	48	3	4
Ellesmere	351	327	—	—	—	20	—	4
Ludlow	479	424	—	—	10	33	6	6
Madeley	705	624	3	—	5	62	8	3
Newport	373	324	—	—	1	36	2	10
Oswestry	769	701	6	—	1	45	3	13
Shifnal	329	301	—	—	—	23	2	3
Wellington	791	674	2	—	11	60	14	30
Wem	255	225	1	—	6	16	2	5
Whitchurch	313	267	2	—	9	21	9	5
	6,896	6,060	20	—	70	540	71	135
SOMERSET.								
Axbridge	944	563	2	—	199	79	21	80
Bath	1,663	1,188	7	—	116	131	112	109
Bridgwater	897	511	—	—	31	84	44	227
Chard	545	468	—	—	5	60	6	6
Clutton	786	611	5	—	65	52	11	42
Dulverton	105	97	—	—	2	2	1	3
Frome	460	367	—	—	58	24	4	7
Keynsham	1,051	658	3	—	47	95	10	238
Langport	304	267	—	—	20	12	3	2
Long Ashton	503	416	2	—	29	24	8	24
Shepton Mallet	378	304	4	—	32	22	7	9
Taunton	870	752	—	—	25	74	3	16
Wellington	429	365	1	—	31	20	1	11
Wells	519	408	—	—	28	32	10	41
Williton	346	294	2	—	11	21	6	12
Wincanton	330	284	—	—	10	22	2	12
Yeovil	649	501	1	—	78	41	10	18
	10,779	8,054	27	—	787	795	259	857
SOUTHAMPTON.								
Alresford	153	133	—	—	1	12	2	5
Alton	395	359	—	—	1	20	4	11
Alverstoke	800	717	3	—	—	56	3	21
Andover	390	303	—	—	48	24	1	14
Basingstoke	572	480	1	—	22	46	8	15
Catherington	61	56	—	—	—	4	—	1
Christchurch	1,293	964	9	—	23	112	26	159
Droxford	291	261	1	—	—	22	—	7
Fareham	476	419	2	—	2	34	3	16
Fordingbridge	146	112	—	—	16	10	—	8

* The figures in this column have no reference to the other columns

1902—continued.

PERCENTAGES of BIRTHS registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					RUTLAND.
91·6	0·4	0·8	1·2	193	Oakham.
86·4	3·6	1·0	10·8	151	Uppingham.
89·2	4·4	1·3	5·7	344	
					SALOP.
87·3	0·6	3·4	4·0	1,063	Atcham.
88·1	1·7	2·5	4·3	325	Bridgnorth.
89·8	1·7	0·6	1·7	129	Church Stretton.
87·1	1·2	4·3	5·5	197	Cleobury Mortimer.
81·4	3·6	5·9	9·5	147	Clun.
84·9	0·3	1·9	2·2	318	Drayton.
91·2	—	1·1	1·1	290	Ellesmere.
88·5	3·1	2·5	4·6	452	Ludlow.
84·6	0·7	1·6	2·3	641	Madeley.
86·9	0·3	3·2	3·5	337	Newport.
91·2	0·1	2·1	2·2	719	Oswestry.
91·5	—	1·5	1·5	267	Shifnal.
85·2	1·4	5·6	7·0	831	Wellington.
88·2	3·4	2·7	5·1	233	Wem.
85·3	2·9	4·5	7·4	388	Whitchurch.
87·9	1·0	3·0	4·0	6,236	
					SOMERSET
59·6	21·1	10·7	31·8	838	Axbridge.
71·4	7·0	13·3	20·3	1,420	Bath.
57·0	3·5	30·2	33·7	486	Bridgwater.
85·9	0·9	2·2	3·1	529	Chard.
77·7	8·3	6·7	15·0	620	Clutton.
93·4	1·9	3·8	5·7	63	Dulverton.
79·8	13·0	2·4	15·0	365	Frome
62·6	4·5	23·8	28·1	669	Keynsham.
67·8	6·6	1·6	8·2	294	Langport.
82·7	5·8	6·4	12·2	496	Long Ashton.
80·4	8·5	4·2	12·7	209	Shepton Mallet.
96·4	2·9	2·2	5·1	790	Taunton.
85·1	7·2	2·8	10·0	370	Wellington.
78·8	5·4	9·8	15·2	440	Wells.
85·0	3·3	5·2	8·4	292	Williton.
86·1	3·0	4·2	7·2	249	Wincanton.
77·2	12·0	4·3	16·3	515	Yeovil.
74·7	7·3	10·4	17·7	8,555	
					SOUTHAMPTON
86·9	3·7	4·6	5·3	126	Alresford
90·8	0·3	3·8	4·1	378	Alton.
89·6	—	5·0	5·0	641	Alverstoke.
77·7	12·3	5·8	18·1	321	Andover.
83·9	3·9	4·0	7·9	495	Basingstoke.
91·8	—	1·6	1·6	46	Catherington.
74·8	1·8	14·3	16·1	1,122	Christchurch.
89·7	—	2·4	2·4	250	Droxford.
95·0	0·4	4·0	4·4	505	Fareham.
78·7	11·0	5·5	16·5	138	Fordingbridge.

in the table, which strictly refer to the births registered in 1902.

t of nation rs' ns, 1902.

	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
SOUTHAMPTON—*cont.*								
Hartley Wintney ..	706	620	—	—	8	50	1	27
Havant	267	226	—	—	1	22	4	4
Hursley	92	78	—	—	—	4	3	9
Kingsclere..	210	193	—	—	6	11	—	1
Lymington	289	246	—	—	1	18	2	22
New Forest	338	295	—	—	—	31	3	19
Petersfield..	281	256	—	—	2	10	1	13
Portsmouth	5,192	4,509	31	—	31	547	26	48
Ringwood..	162	152	—	—	2	3	4	1
Romsey	257	221	—	—	8	13	—	5
Southampton	1,739	1,447	3	—	19	159	17	54
South Stoneham ..	2,510	2,106	2	—	27	168	55	152
Stockbridge	146	126	—	—	10	8	1	1
Whitchurch	148	124	—	—	4	17	1	2
Wight, Isle of	1,697	1,405	5	—	73	112	25	77
Winchester	735	640	2	—	29	46	7	11
	19,336	16,455	59	—	334	1,549	197	742
STAFFORD.								
Burton-on-Trent ..	2,698	2,020	4	—	95	231	5	343
Cannock	1,776	1,556	2	—	21	163	6	28
Cheadle	749	670	—	—	3	57	6	13
Leek	1,339	1,127	—	—	39	139	23	11
Lichfield	1,309	1,105	2	—	4	137	22	39
Newcastle-under-Lyme	1,358	1,212	—	—	5	119	7	15
Seisdon	478	396	—	—	17	37	4	24
Stafford	841	686	4	—	33	76	16	26
Stoke-upon-Trent ..	5,758	4,306	8	—	7	729	226	482
Stone	484	421	1	—	1	51	8	2
Tamworth	777	654	—	—	2	64	6	51
Uttoxeter	439	393	—	—	2	34	6	4
Walsall	4,344	3,435	14	—	43	497	37	318
West Bromwich ..	5,687	4,462	15	—	110	641	98	361
Wolstanton and Burslem	3,921	3,284	14	—	5	437	10	171
Wolverhampton ..	5,370	3,504	21	—	154	570	60	1,061
	37,328	29,231	85	—	541	3,982	540	2,949
SUFFOLK.								
Blything	664	606	1	—	6	40	1	10
Bosmere and Claydon..	380	326	—	—	2	21	1	10
Bury St. Edmunds ..	387	322	1	—	2	42	5	15
Cosford	362	322	1	—	5	32	2	—
Hartismere	321	280	—	—	—	28	3	10
Hoxne	248	216	—	—	1	25	—	6
Ipswich	1,874	1,056	4	—	270	194	33	317
Mildenhall	189	171	—	—	1	11	3	3
Mutford and Lothingland	1,378	1,076	2	—	22	106	19	153
Plomesgate	449	377	1	—	6	48	8	9
Risbridge	425	372	—	—	8	33	6	6
Samford	321	289	2	—	3	18	4	5
Stow	488	437	—	—	6	37	1	7
Sudbury	570	507	—	—	12	29	7	15
Thingoe	348	324	—	—	—	18	2	4
Wangford	371	325	—	—	5	29	6	6
Woodbridge	608	541	—	—	6	37	6	18
	9,363	7,547	12	—	355	748	107	594

* The figures in this column have no reference to the other columns

1902—*continued.*

PERCENTAGES of BIRTHS registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	—
Successfully vaccinated	Exempted by "Conscientious Objection" Certificates	Not finally accounted for, including cases postponed.	Unvaccinated.		
(1.)	(2.)	(3.)	(Cols. 2 & 3.)		
					SOUTHAMPTON—*cont.*
87·8	1·1	4·0	5·1	618	Hartley Wintney.
87·9	0·4	3·1	3·5	239	Havant.
82·6	—	13·0	13·0	90	Hursley.
91·4	2·9	0·5	3·4	187	Kingsclere.
85·1	5·3	6·3	8·6	293	Lymington.
87·3	—	6·5	6·5	329	New Forest.
91·1	0·7	4·6	5·3	297	Petersfield.
93·9	0·6	1·4	2·0	4,819	Portsmouth.
93·8	1·2	3·1	4·3	153	Ringwood.
89·9	3·1	1·9	5·0	226	Romsey.
83·2	1·1	6·4	7·5	1,489	Southampton.
83·9	1·1	6·2	9·3	2,118	South Stoneham.
86·3	6·9	1·4	8·3	96	Stockbridge.
85·8	3·7	2·0	4·7	158	Whitchurch.
83·6	4·3	6·0	10·3	1,436	Wight, Isle of.
87·1	4·0	2·4	6·4	643	Winchester.
85·1	1·7	4·9	6·6	17,363	
					STAFFORD.
74·9	3·5	12·9	[illegible]·4	2,291	Burton-on-Trent.
87·6	1·3	1·9	3·1	1,776	Cannock.
89·5	0·4	2·5	2·9	702	Cheadle.
84·2	2·9	2·5	5·4	1,132	Leek.
84·4	0·3	4·7	5·0	1,208	Lichfield.
89·2	0·4	1·6	2·0	1,238	Newcastle-under-Lyme.
82·8	3·6	6·9	9·5	386	Seisdon.
81·6	3·9	5·0	8·9	722	Stafford.
74·8	0·1	13·3	12·4	4,568	Stoke-upon-Trent.
87·0	0·2	2·1	2·3	448	Stone.
84·2	0·3	7·3	7·6	780	Tamworth.
89·5	0·5	2·3	2·8	363	Uttoxeter.
79·1	1·0	8·2	9·2	3,697	Walsall.
78·6	1·9	8·1	10·0	5,166	West Bromwich.
83·8	0·1	4·6	4·7	3,427	Wolstanton and Burslem
85·3	2·9	20·9	23·8	3,844	Wolverhampton.
78·3	1·4	9·3	10·7	31,940	
					SUFFOLK.
91·3	0·9	1·7	2·6	632	Blything.
90·6	0·6	3·1	3·7	302	Bosmere and Claydon.
88·2	0·5	5·2	5·7	373	Bury St. Edmunds.
88·9	1·4	0·8	2·0	353	Cosford.
87·2	—	4·0	4·0	304	Hartismere.
87·1	0·4	2·4	2·8	231	Hoxne.
56·4	14·4	18·7	33·1	1,120	Ipswich.
90·5	0·5	3·3	3·7	149	Mildenhall.
78·1	1·8	12·5	14·1	1,095	Mutford and Lothingland.
84·0	1·3	3·8	5·1	395	Plomesgate.
87·6	1·9	2·8	4·7	380	Risbridge.
90·0	0·9	2·8	3·7	278	Samford.
89·5	1·3	1·8	3·8	460	Stow.
88·9	2·1	3·9	6·0	480	Sudbury.
98·1	—	1·7	1·7	316	Thingoe.
87·6	1·4	3·2	4·6	311	Wangford.
89·0	1·0	3·9	4·9	658	Woodbridge.
89·8	3·8	7·5	11·3	7,727	

in the table, which strictly refer to the births registered in 1902.

—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
SURREY (EXTRA-METROPOLITAN).								
Chertsey	940	788	6	—	12	70	16	48
Croydon	5,004	3,923	23	—	87	469	54	452
Dorking	381	291	1	—	43	30	10	6
Epsom	1,403	1,093	—	—	13	101	45	151
Farnham	1,572	1,387	5	—	10	103	3	64
Godstone	635	537	—	—	10	47	4	37
Guildford	1,445	1,134	2	—	74	93	59	84
Hambledon	496	434	2	—	8	40	1	11
Kingston	3,495	2,778	11	—	64	315	80	247
Reigate	962	768	4	—	86	66	10	28
Richmond	1,126	970	19	—	10	76	2	49
	17,459	14,103	73	—	417	1,460	284	1,183
SUSSEX.								
Battle	516	424	2	—	29	44	3	15
Brighton	2,466	1,745	13	—	105	243	19	341
Chichester	291	253	—	—	6	16	4	12
Cuckfield	569	472	1	—	25	37	16	18
Eastbourne	1,077	348	2	—	336	84	52	255
East Grinstead	436	315	—	—	50	20	23	28
East Preston	869	722	2	—	15	66	27	37
Hailsham	429	264	—	—	107	31	2	25
Hastings	1,192	884	6	—	59	106	9	128
Horsham	672	573	2	—	21	42	6	28
Lewes	476	270	—	—	136	49	5	16
Midhurst	324	287	—	—	1	23	2	11
Newhaven	293	175	—	—	82	16	3	17
Petworth	183	167	—	—	—	13	—	3
Rye	259	209	—	—	21	19	1	9
Steyning	1,850	1,401	6	—	109	146	37	151
Thakeham	187	167	1	—	—	7	5	7
Ticehurst	356	285	1	—	24	19	5	22
Uckfield	528	362	—	—	109	22	22	13
Westbourne	169	148	—	—	—	15	2	4
Westhampnett	412	359	1	—	4	26	7	15
	13,554	9,830	37	—	1,239	1,044	249	1,155
WARWICK.								
Alcester	524	457	1	—	17	42	3	4
Aston	10,248	7,696	66	—	42	1,190	163	1,091
Atherstone	658	441	—	—	40	63	30	84
Birmingham	7,990	6,120	23	—	31	1,019	58	739
Coventry	2,046	1,549	3	—	225	175	44	50
Foleshill	645	495	—	—	67	75	—	8
Meriden	223	182	—	—	5	11	—	25
Nuneaton	991	575	—	—	205	87	—	124
Rugby	944	383	—	—	66	82	6	407
Solihull	1,456	1,224	7	—	12	121	2	90
Southam	224	156	1	—	20	18	1	38
Stratford-on-Avon ..	402	337	—	—	19	35	3	8
Warwick	1,134	946	3	—	49	88	7	41
	27,465	20,561	104	—	798	3,006	317	2,699

* The figures in this column have no reference to the other columns

1902—*continued.*

PERCENTAGES of BIRTHS registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	
Successfully vaccinated.	Exempted by "Conscientious Objection" Certificates.	Not finally accounted for, including cases postponed.	Unvaccinated.		
(1.)	(2.)	(3.)	(Cols. 2 & 3.)		
					SURREY (EXTRA-METROPOLITAN).
83·4	1·3	6·4	8·1	902	Chertsey.
78·4	1·7	10·3	11·9	5,128	Croydon.
78·4	11·3	4·2	15·5	269	Dorking.
77·9	6·9	14·0	14·9	1,259	Epsom.
88·2	0·6	4·3	4·9	1,487	Farnham.
91·6	1·6	6·6	8·1	645	Godstone.
78·5	5·1	9·9	15·0	1,121	Guildford.
87·6	1·6	2·4	4·0	462	Hambledon.
79·5	1·6	9·4	11·2	3,324	Kingston.
79·8	8·9	4·0	12·9	757	Reigate.
86·1	0·9	4·5	5·4	1,091	Richmond.
80·8	2·4	8·4	10·8	16,455	
					SUSSEX.
82·2	5·4	3·3	8·9	485	Battle.
70·8	4·3	14·6	18·9	2,038	Brighton.
86·9	2·1	5·5	7·6	231	Chichester.
83·0	4·4	6·0	10·4	474	Cuckfield.
32·3	31·2	29·5	60·7	414	Eastbourne.
72·2	11·5	11·7	23·2	309	East Grinstead.
83·1	1·7	7·4	9·1	738	East Preston.
61·5	24·9	6·8	31·2	260	Hailsham.
74·2	5·0	11·3	16·5	846	Hastings.
85·3	3·1	5·1	8·2	551	Horsham.
56·7	28·6	4·4	33·0	346	Lewes.
88·6	0·3	4·0	4·3	202	Midhurst
39·7	26·0	6·8	34·8	106	Newhaven.
91·3	-	1·6	1·6	194	Petworth.
80·7	8·1	3·9	12·0	205	Rye.
75·7	5·9	10·2	16·1	1,490	Steyning.
89·3	—	6·4	6·4	173	Thakeham.
80·1	6·7	7·6	14·3	305	Ticehurst.
66·6	30·6	6·6	37·2	386	Uckfield.
87·6	—	5·6	5·6	144	Westbourne.
87·1	1·0	5·3	6·3	427	Westhampnett.
72·5	5·1	10·4	19·5	10,446	
					WARWICK.
87·2	3·2	1·3	4·5	456	Alcester.
75·2	0·4	12·2	13·6	8,955	Aston.
67·0	6·1	17·3	23·4	444	Atherstone.
76·6	0·4	10·0	10·4	6,902	Birmingham.
75·7	11·0	4·6	15·6	2,392	Coventry.
76·7	10·4	1·2	11·6	648	Foleshill.
81·6	2·2	11·2	13·4	211	Meriden.
58·0	20·7	12·5	33·2	431	Nuneaton.
40·6	7·0	43·7	50·7	459	Rugby.
91·1	0·8	6·3	7·1	1,358	Solihull.
69·6	8·9	12·9	21·8	190	Southam
83·6	4·7	2·7	7·4	340	Stratford-on-Avon.
85·4	4·3	4·2	8·5	938	Warwick.
71·6	2·9	11·0	13·9	23,712	

in the table, which strictly refer to the births registered in 1902,

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—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
WESTMORLAND.								
East Ward	301	253	—	—	15	21	6	6
Kendal	934	849	4	—	2	63	10	6
West Ward	175	162	—	—	1	6	4	2
	1,410	1,264	4	—	18	90	20	14
WILTS.								
Amesbury	176	145	1	—	9	11	—	10
Bradford-on-Avon ..	216	97	—	—	22	13	—	84
Calne	173	93	—	—	12	9	7	52
Chippenham	573	332	—	—	66	49	—	126
Cricklade and Wootton Bassett.	315	176	—	—	96	17	9	17
Devizes	425	266	—	—	105	35	11	8
Malmesbury	315	244	—	—	21	25	5	20
Marlborough	188	168	1	—	5	11	1	2
Mere	112	96	—	—	3	6	5	—
Pewsey	265	222	—	—	15	24	1	3
Salisbury	703	491	3	—	111	46	30	22
Swindon and Highworth.	1,748	949	4	—	548	133	38	76
Tisbury	188	176	—	—	—	6	—	6
Trowbridge and Melksham.	406	109	—	—	18	30	49	200
Warminster	212	185	—	—	12	11	1	3
Westbury and Whorwellsdown.	208	173	1	—	6	9	2	17
Wilton	215	165	—	—	27	17	1	5
	6,438	4,089	10	—	1,076	452	160	651
WORCESTER.								
Bromsgrove	1,005	881	4	—	13	73	10	34
Droitwich	453	401	—	—	3	35	—	14
Dudley	5,521	4,560	21	—	51	544	66	279
Evesham	490	355	2	—	96	28	3	6
Kidderminster	1,008	882	2	—	13	93	5	13
King's Norton	5,503	4,377	32	—	81	503	73	437
Martley	314	291	—	—	1	21	—	1
Pershore	312	283	1	—	2	23	2	1
Shipston-on-Stour ..	372	310	1	—	31	25	3	2
Stourbridge	3,156	2,783	12	—	18	272	21	50
Tenbury	158	132	—	—	1	11	9	5
Upton-on-Severn ..	565	491	4	—	12	39	7	12
Worcester	1,232	878	—	—	15	148	52	139
	20,089	16,624	79	—	337	1,815	251	983
YORK, EAST RIDING.								
Beverley	642	536	—	—	22	59	3	22
Bridlington	524	441	3	—	18	41	5	16
Driffield	433	307	2	—	19	30	5	10
Howden	323	276	1	—	1	39	1	5
Kingston-upon-Hull ..	2,454	1,847	12	—	12	274	17	292
Patrington	206	185	—	—	4	16	—	1
Pocklington	381	323	—	—	7	38	10	3
Sculcoates	5,730	4,834	27	—	25	553	40	251
Skirlaugh	220	201	1	—	1	15	—	2
York	2,564	2,210	8	—	43	177	17	109
	13,477	11,220	54	—	152	1,242	98	711

* The figures in this column have no reference to the other columns

1903—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	
Successfully vaccinated.	Exempted by "Conscientious Objection" Certificates.	Not finally accounted for, including cases postponed.	Unvaccinated.		
(1.)	(2.)	(3.)	(Cols. 2 & 3.)		
					WESTMORLAND.
84·1	5·0	4·0	9·0	249	East Ward.
90·9	0·2	1·7	1·9	672	Kendal.
92·6	0·8	3·4	4·0	194	West Ward.
89·6	1·3	3·4	3·7	1,315	
					WILTS.
82·4	5·1	5·7	10·8	182	Amesbury.
44·9	10·2	38·9	49·1	106	Bradford-on-Avon.
58·8	6·9	34·1	41·0	135	Calne.
67·9	11·5	22·0	33·5	516	Chippenham.
55·9	30·5	6·2	36·6	196	Cricklade and Wootton Bassett.
68·6	24·7	4·5	29·2	200	Devizes.
77·5	5·7	7·9	14·6	327	Malmesbury.
89·4	2·7	1·6	4·3	178	Marlborough.
87·5	3·7	4·5	7·2	116	Mere.
83·8	5·7	1·5	7·2	254	Pewsey.
69·8	15·6	7·4	23·2	480	Salisbury.
54·5	31·4	6·5	37·9	973	Swindon and Highworth.
93·6	—	3·2	3·2	178	Tisbury.
26·8	4·4	61·5	65·7	94	Trowbridge and Melksham.
87·3	5·7	1·9	7·6	218	Warminster.
83·2	3·9	9·1	13·0	184	Westbury and Whorwellsdown.
76·7	12·6	2·8	15·4	170	Wilton.
69·5	16·7	12·8	29·3	4,296	
					WORCESTER.
87·7	1·3	3·4	4·7	[redacted]	Bromsgrove.
88·5	0·7	3·1	3·8	444	Droitwich.
82·6	0·9	6·2	7·1	4,997	Dudley.
72·4	19·8	1·8	21·4	388	Evesham.
87·6	1·3	1·8	3·1	934	Kidderminster.
79·5	1·6	9·3	10·6	5,102	King's Norton.
92·7	0·3	0·5	0·6	280	Martley.
90·7	0·4	1·0	1·6	276	Pershore.
89·3	6·3	1·3	9·6	299	Shipston-on-Stour.
88·2	0·6	2·2	2·8	2,941	Stourbridge.
89·6	0·6	8·9	9·5	162	Tenbury.
86·9	2·1	3·4	5·6	511	Upton-on-Severn.
71·3	1·2	15·5	16·7	988	Worcester.
83·6	1·7	6·1	7·8	18,256	
					YORK, East Riding.
85·5	3·4	3·9	8·3	569	Beverley.
84·3	3·4	4·0	7·4	401	Bridlington.
84·8	4·4	3·6	7·9	389	Driffield. ..
85·4	0·3	1·9	2·2	294	Howden.
75·2	0·5	12·6	13·1	1,947	Kingston-upon-Hull.
89·6	1·9	0·5	2·4	306	Patrington.
84·3	1·8	3·4	5·2	333	Pocklington.
84·4	0·4	5·1	5·5	4,995	Sculcoates.
91·4	0·5	0·2	1·4	231	Skirlaugh.
88·2	1·6	4·3	6·5	2,231	York.
88·3	1·1	6·0	7·1	11,840	

in the table, which strictly refer to the births registered in 1902.

P. A., No. 14.

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RETURNS,

	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
YORK, NORTH RIDING.								
Aysgarth	107	97	1	—	1	7	1	—
Bedale	210	187	—	—	6	16	1	—
Easingwold	236	211	—	—	2	19	1	4
Guisborough	1,394	1,036	7	—	41	104	23	63
Helmsley	114	105	—	—	1	6	—	2
Kirkby Moorside ..	124	109	—	—	1	12	—	2
Leyburn	135	123	—	—	2	9	—	1
Malton	502	436	1	—	15	37	7	6
Middlesbrough	5,911	3,878	12	—	89	683	157	452
Northallerton	309	270	—	—	5	25	—	9
Pickering	263	214	—	—	9	24	9	7
Reeth	68	63	—	—	—	3	—	2
Richmond	289	231	—	—	1	15	5	8
Scarborough	1,231	519	3	—	270	116	6	316
Stokesley	295	253	4	—	13	18	1	19
Thirsk	299	262	—	—	4	24	3	5
Whitby	509	453	2	—	12	34	3	3
	11,156	8,459	30	—	410	1,149	216	892
YORK, WEST RIDING.								
Barnsley	4,508	3,767	31	—	32	502	39	147
Bierley, North	2,930	2,296	12	—	100	251	40	229
Bradford	5,249	3,934	13	1	269	508	69	369
Bramley	2,349	1,890	16	—	60	261	44	78
Dewsbury	4,282	2,146	12	—	367	457	89	1,181
Doncaster	2,774	2,191	6	—	127	279	56	[illegible]
Ecclesall Bierlow ..	5,757	4,890	56	—	26	610	39	337
Goole	815	708	2	—	3	93	2	7
Halifax	4,143	675	1	—	5	539	7	2,916
Hemsworth	936	780	—	—	10	109	6	31
Holbeck	1,150	933	4	—	26	111	22	54
Huddersfield	5,983	3,433	20	—	88	344	29	66
Hunslet	3,713	2,193	20	—	35	[illegible]	22	101
Keighley	1,912	944	—	—	929	180	8	151
Knaresborough .. .	1,031	725	3	—	61	90	80	92
Leeds	7,404	5,861	44	—	82	777	86	555
Ouseburn, Great ..	240	211	—	—	7	13	1	9
Pateley Bridge	221	190	—	—	1	15	1	17
Penistone	489	408	2	—	6	38	33	10
Pontefract	2,730	2,123	13	—	53	508	31	203
Ripon	341	283	—	—	7	38	—	13
Rotherham	4,172	3,607	23	—	13	361	9	69
Saddleworth	395	271	—	—	69	40	2	13
Sedbergh	9	77	—	—	—	7	2	—
Selby	477	433	—	—	4	31	3	6
Settle	351	295	1	—	17	21	9	8
Sheffield	8,582	7,030	91	—	44	943	[illegible]	431
Skipton	1,113	556	6	—	366	108	73	103
Tadcaster	962	843	8	—	2	79	6	24
Thorne	483	345	—	—	33	61	6	18
Wakefield	3,822	3,120	9	—	73	322	21	77
Wetherby	318	281	—	—	3	28	5	1
Wharfedale	1,330	1,103	2	—	37	109	8	72
Wortley	1,347	1,145	3	—	6	112	24	57
	70,152	59,270	402	1	2,881	8,146	873	7,579

* The figures in this column have no reference to the other columns

1902—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at all ages received during the calendar year 1903.	—
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					YORK, North Riding.
80·7	0·9	6·9	1·6	104	Aysgarth.
89·0	3·9	0·5	5·4	194	Bedale.
89·4	0·8	2·1	3·9	203	Easingwold.
81·6	3·2	6·6	9·8	1,275	Guisborough.
92·1	0·9	1·8	2·7	112	Helmsley.
87·9	0·8	1·6	2·4	98	Kirkby Moorside.
91·1	1·5	0·7	2·2	124	Leyburn.
88·9	3·0	2·6	5·6	481	Malton.
74·4	0·6	11·7	12·3	4,076	Middlesbrough.
87·4	1·6	2·9	4·5	269	Northallerton.
81·4	3·4	6·1	9·5	220	Pickering.
91·4	—	3·4	3·4	57	Reeth.
88·8	0·4	5·0	5·4	207	Richmond.
42·3	21·9	35·2	48·1	919	Scarborough
85·8	3·7	3·7	7·4	225	Stokesley.
87·9	1·3	2·7	4·0	259	Thirsk.
89·4	2·4	1·2	3·6	470	Whitby.
76·8	3·7	9·9	13·6	9,441	
					YORK, West Riding.
89·5	0·5	4·1	4·6	4,109	Barnsley.
78·5	2·4	9·2	13·6	2,773	Bierley, North.
75·9	5·1	8·7	13·8	4,513	Bradford.
90·5	2·8	6·2	7·8	2,039	Bramley.
59·4	9·5	29·5	38·6	3,350	Dewsbury.
79·0	4·8	6·2	10·8	2,188	Doncaster.
81·5	6·5	6·5	7·0	4,237	Ecclesall Bierlow.
98·9	0·4	1·1	1·5	754	Goole.
16·8	0·1	70·6	70·7	2,429	Halifax.
93·9	1·1	4·0	5·1	854	Hemsworth.
81·1	2·5	6·4	8·9	1,053	Holbeck.
89·9	2·3	2·4	4·6	3,941	Huddersfield.
90·8	1·3	4·5	5·8	2,458	Hunslet.
33·7	48·6	8·3	56·9	854	Keighley.
70·3	5·9	14·7	20·6	881	Knaresborough.
79·2	1·1	8·6	9·7	6,054	Leeds.
87·8	3·9	2·7	6·6	209	Ouseburn, Great.
94·8	0·5	3·0	3·5	164	Pateley Bridge.
81·8	1·2	8·8	10·0	480	Penistone.
77·8	1·9	6·8	10·5	2,205	Pontefract.
85·0	2·1	3·6	5·9	339	Ripon.
88·8	0·8	1·9	2·2	4,079	Rotherham.
69·6	17·5	3·8	21·3	568	Saddleworth.
89·5	—	3·3	3·3	64	Sedbergh.
90·3	0·8	1·9	2·7	462	Selby.
84·0	4·6	4·6	9·6	313	Settle.
81·9	0·5	5·5	6·0	7,330	Sheffield.
50·8	24·1	15·8	39·9	636	Skipton.
87·6	0·2	5·1	3·3	917	Tadcaster.
74·5	7·1	5·2	12·3	306	Thorne.
88·1	3·0	3·7	4·7	3,290	Wakefield.
88·4	0·9	1·9	2·8	208	Wetherby.
82·9	2·8	6·0	8·8	1,196	Wharfedale.
95·0	0·5	0·0	0·5	1,052	Wortley.
74·9	3·8	10·7	14·5	66,769	

In the table, which strictly refer to the births registered in 1902.

—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
ANGLESEY.								
Anglesey	332	288	—	—	1	39	1	3
Holyhead	550	505	—	—	—	40	2	3
	882	793	—	—	1	79	3	6
BRECKNOCK.								
Brecknock	378	337	1	—	1	28	2	9
Builth	218	153	—	—	—	24	30	11
Crickhowell	782	669	—	—	3	78	12	30
Hay	240	186	—	—	8	25	5	6
	1,618	1,345	1	—	12	155	49	56
CARDIGAN.								
Aberayron	218	193	1	—	—	18	3	3
Aberystwyth	454	394	—	—	4	40	7	9
Cardigan	324	273	1	—	6	35	7	2
Lampeter	193	166	—	—	2	22	1	2
Tregaron	156	140	—	—	—	14	2	—
	1,345	1,166	2	—	12	129	20	16
CARMARTHEN.								
Carmarthen	812	696	1	—	—	107	3	5
Llandilo Fawr	749	674	—	—	2	65	5	3
Llandovery	216	186	—	—	—	24	6	—
Llanelly	1,824	1,503	—	—	2	193	112	14
Newcastle-in-Emlyn ..	422	364	—	—	—	58	3	7
	4,023	3,413	1	—	4	447	129	39
CARNARVON.								
Bangor and Beaumaris	943	830	4	—	3	94	3	9
Carnarvon	1,176	1,046	1	—	—	111	12	6
Conway	871	754	—	—	2	97	6	12
Pwllheli	493	414	—	—	—	63	—	16
	3,483	3,044	5	—	5	365	21	43
DENBIGH.								
Llanrwst	321	255	1	—	—	49	12	4
Ruthin	264	237	—	—	—	23	3	1
Wrexham	2,518	2,254	1	1	8	215	14	25
	3,103	2,746	2	1	8	287	29	30

* The figures in this column have no reference to the other columns

1902—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1903.	—
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					ANGLESEY.
86·7	0·5	1·2	1·5	305	Anglesey.
91·8	—	0·9	0·9	652	Holyhead.
89·9	**0·1**	**1·0**	**1·1**	**957**	
					BRECKNOCK.
89·2	0·5	2·9	3·2	402	Brecknock.
79·2	—	18·6	18·6	172	Builth.
84·3	0·4	5·4	5·8	652	Crickhowell.
91·7	3·3	4·6	7·9	186	Hay.
88·1	**0·7**	**6·5**	**7·2**	**1,415**	
					CARDIGAN.
96·5	—	3·3	3·3	193	Aberayron.
90·3	0·9	3·6	4·4	429	Aberystwyth.
84·3	1·9	2·8	4·7	316	Cardigan.
93·6	1·0	1·6	2·6	149	Lampeter.
98·7	—	1·3	1·3	149	Tregaron.
90·7	**0·9**	**2·7**	**3·6**	**1,236**	
					CARMARTHEN.
95·7	—	1·0	1·0	725	Carmarthen.
93·0	0·3	1·1	1·4	748	Llandilo Fawr.
95·1	—	2·3	2·3	130	Llandovery.
92·4	0·1	6·9	7·0	1,502	Llanelly.
95·9	—	3·4	3·4	405	Newcastle-in-Emlyn.
94·8	**0·1**	**3·9**	**4·0**	**3,530**	
					CARNARVON.
96·9	0·3	1·3	1·6	902	Bangor and Beaumaris
93·9	—	1·6	1·5	1,042	Carnarvon.
95·6	0·2	2·1	2·3	325	Conway
94·9	—	5·2	5·2	401	Pwllheli.
97·4	**0·1**	[illegible]	**1·9**	**3,220**	
					DENBIGH.
79·4	—	5·0	5·0	204	Llanrwst.
89·8	—	1·5	1·5	181	Ruthin
89·5	0·3	1·6	1·8	2,330	Wrexham.
88·6	**0·3**	**1·9**	**2·2**	**2,715**	

In the table, which strictly refer to the births registered in 1902

No. 14.

—	Births.	Successfully vaccinated.	Insusceptible of vaccination.	Had Small-pox.	Number in respect of whom Certificates of Conscientious Objection have been received.	Died unvaccinated.	Vaccination postponed.	Remaining.
FLINT.								
Asaph, St.	711	604	1	—	1	68	9	28
Hawarden	730	629	2	—	1	61	14	23
Holywell	1,064	951	—	—	—	68	30	15
	2,505	2,184	3	—	2	197	53	66
GLAMORGAN.								
Bridgend and Cowbridge	2,612	2,129	1	—	10	265	74	113
Cardiff	7,261	5,796	45	—	82	747	35	580
Gower	323	281	1	—	—	21	3	6
Merthyr Tydfil	5,469	4,859	3	1	20	310	68	108
Neath	2,726	2,367	5	—	3	245	24	84
Pontardawe	998	840	1	—	—	96	21	13
Pontypridd	8,633	6,772	7	—	20	1,023	155	647
Swansea	3,775	3,190	7	1	7	370	1	199
	31,799	26,046	63	2	122	3,404	381	1,769
MERIONETH.								
Bala	129	110	—	—	2	10	6	1
Corwen	430	380	—	—	—	36	11	4
Dolgelly	342	315	1	—	1	22	3	1
Festiniog	780	676	—	—	—	75	10	19
	1,681	1,481	1	—	3	142	29	25
MONTGOMERY.								
Forden	341	294	—	—	—	30	11	6
Llanfyllin	419	369	—	—	1	37	9	9
Machynlleth	282	181	—	—	—	24	2	25
Newtown and Llanidloes	565	497	2	—	—	41	6	29
	1,557	1,325	2	—	1	132	28	69
PEMBROKE.								
Haverfordwest	917	790	2	—	1	91	11	23
Narberth	429	384	1	—	—	42	1	1
Pembroke	834	706	7	—	1	86	20	14
	2,180	1,880	10	—	2	219	32	37
RADNOR.								
Knighton	280	210	—	—	—	26	2	42
Rhayader	252	78	1	—	1	28	1	143
	532	288	1	—	1	54	3	185

* The figures in this column have no reference to the other columns

1902—*continued.*

Percentages of Births registered in 1902.				Total Number of Certificates of Successful Primary Vaccination at ALL AGES received during the calendar year 1902.	—
Successfully vaccinated. (1.)	Exempted by "Conscientious Objection" Certificates. (2.)	Not finally accounted for, including cases postponed. (3.)	Unvaccinated. (Cols. 2 & 3.)		
					FLINT.
95·0	0·1	5·2	5·3	626	Asaph, St.
93·3	0·1	5·1	5·2	652	Hawarden.
99·4	—	4·2	4·2	1,022	Holywell.
97·2	0·1	4·8	4·9	2,300	
					GLAMORGAN.
91·5	0·4	7·2	7·6	2,235	Bridgend and Cowbridge.
79·6	0·9	8·7	9·6	6,525	Cardiff.
90·4	—	2·8	2·8	315	Gower.
95·2	0·4	3·2	3·6	4,457	Merthyr Tydfil.
96·8	0·1	4·0	4·1	2,412	Neath.
93·9	—	5·5	5·5	931	Pontardawe.
76·5	0·2	9·3	9·5	7,931	Pontypridd.
94·5	0·2	5·3	5·5	3,949	Swansea.
91·9	0·4	6·8	7·2	28,155	
					MERIONETH.
95·3	1·6	5·4	7·0	108	Bala.
93·4	—	3·5	3·5	372	Corwen.
98·1	0·3	0·9	1·2	223	Dolgelly.
96·7	—	3·7	3·7	713	Festiniog
96·1	0·2	3·2	3·4	1,416	
					MONTGOMERY.
95·2	—	5·0	5·0	295	Forden.
95·8	0·2	4·3	4·5	348	Llanfyllin.
78·0	—	11·6	11·6	301	Machynlleth.
96·2	—	6·2	6·2	456	Newtown and Llanidloes.
95·1	0·1	6·2	6·3	1,300	
					PEMBROKE.
96·3	0·1	3·6	3·7	896	Haverfordwest.
99·5	—	0·5	0·5	377	Narberth.
94·7	0·1	4·1	4·2	730	Pembroke.
96·8	0·1	3·2	3·3	2,003	
					RADNOR.
76·9	—	15·7	15·7	232	Knighton.
31·0	0·4	67·1	67·5	110	Rhayader.
64·1	0·2	35·3	35·5	342	

in the table, which strictly refer to the births registered in 1902.

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REPORT on the ARRANGEMENTS in GERMANY for the ISOLATION of SMALL-POX cases; by Dr. R. BRUCE LOW.

Conflicting statements having been made from time to time in the public press as to the methods employed in Germany in dealing with small-pox patients, the President of the Local Government Board determined to obtain through his medical staff information, collected personally in Germany, of a sort to enable him to contrast the actual methods employed there with those existing in England and Wales. The mission was entrusted to me, and I visited a number of the principal towns in Germany during the autumn of 1903.

As a preliminary to my inquiry, I proceeded to Berlin to confer with the officials of the Central Imperial Health Office,* and to ascertain from them if it were possible to see current small-pox cases undergoing isolation. But as no cases of the disease existed in Germany, so far as the Central Health Office were aware at the time of my visit, it was arranged that I should visit representative towns in the four chief States of the German Empire, viz., Berlin, Cologne, Frankfort-on-Main, Wiesbaden, and Mainz, in the kingdom of Prussia; Munich and Nuremberg, in the kingdom of Bavaria; Dresden and Leipzig, in the kingdom of Saxony; and Stuttgart, in the kingdom of Württemberg. I accordingly visited these ten towns, conferred—except at Mainz, where circumstances compelled me to be content with the evidence of lay officials—with the physicians of the hospitals at each place, inspected the accommodation provided for small-pox cases, and obtained also information on the subject of my inquiry from local medical men, municipal officials, and others. While in Berlin I had the advantage of conferring with Dr. Pistor (Geheimer Ober-Medicinalrat und vortragender Rat im Ministerium der Geistlichen Unterrichts und Medicinal Angelegenheiten), from whom I received valuable documentary evidence.

At the Central Imperial Health Office at Berlin I obtained the following general information on the subject of my inquiry :—

The regulations as to notification and isolation of small-pox cases in the German Empire are drawn up in compliance with the "Law concerning the combating of diseases which constitute a common danger." This law is dated June 30th, 1900.† The regulations in force prior to the law of 1900 did not differ in any essential features.

The notification of small-pox is obligatory throughout the German Empire, and the persons required to notify the disease to the police authorities are : (1) the attending medical practitioner,

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* Kaiserliches Gesundheitsamt.

† Gesetz betreffend die Bekämpfung gemeingefährlicher Krankheiten vom 30 Juni, 1900.

(2) the head of the household, (3) any person who has attended on or nursed the patient, (4) the person in whose dwelling or lodging the case or death has occurred, and (5) the Coroner. "Those named in (2) to (5) are only bound to give notice if the first-named is not at hand." As soon as the police authorities of the district have received notification of the occurrence of small-pox, the information is at once communicated to the Medical Officer of Health, whose duty it is to examine immediately into the circumstances of the case, and to make a report thereon. All persons suffering from small-pox, or suspected to be suffering from small-pox, can be ordered to hospital for isolation if, in the opinion of the medical adviser of the local authority, the patient cannot be properly isolated at his home. In particular cases where the condition of the sick person is so grave as to make, in the view of his medical attendant, his removal to hospital dangerous to life, he may be allowed to remain at home. I was informed also that in rural districts remote from any hospital the patient might also, with the consent of the Medical Officer of Health, be permitted to remain at home during his illness.

On the occurrence of a case of small-pox in a house, the "contacts" are immediately vaccinated or re-vaccinated. In some towns, the "contacts" are removed to a place of isolation till the danger of their developing small-pox has passed.

In Germany separate small-pox hospitals are not provided, except in rare instances. Cases of this disease are, as a rule, removed to the general hospital of the town or district, where commonly a pavilion is kept always in readiness. Not unfrequently it is thought enough to clear out the patients from some occupied pavilion and transfer them elsewhere, so as to make room for the small-pox case or cases. In a very few instances, as for example, at Frankfort-on-Main, the portion of the general hospital site on which the small-pox pavilion stands is fenced by a stone or brick wall, to prevent communication between the other parts of the hospital and that on which small-pox cases are isolated. This pavilion is, in the absence of small-pox, commonly used for the treatment of other maladies, infectious or otherwise as required. Occasionally, as at Dresden, arrangements are made to erect a temporary wooden fence round the small-pox pavilion as soon as a case is admitted. But generally, as has been said, small-pox cases are isolated in a pavilion standing on the site of the general hospital, and in no way shut off from the rest of the establishment. In most cases this pavilion is supplied with food from the central kitchen, and the soiled linen of small-pox patients is sent to the general laundry after being steeped in some disinfecting solution. The nurses and the medical officer or any other persons whose business brings them into relation with the small-pox pavilion are at once re-vaccinated as a matter of routine; but re-vaccination of the whole hospital *personnel* is not carried out, reliance being placed on the statutory vaccination and re-vaccination of the general population under the German Vaccination Law of April 8th, 1874.*

* Young children must be vaccinated before the end of the calendar year following the year of birth: and all school children must be re-vaccinated in their twelfth year. Obedience to this law is enforced by fine or imprisonment.

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Making inquiry as to whether small-pox had been observed to spread from the isolation pavilion to the rest of the general hospital or to houses in the immediate neighbourhood, I was informed by Dr. Wutzdorff (Geheimer Regierungsrat und Director im Kaiserlichen Gesundheitsamt) that instances of such spread were very rare, and that when they did occur the persons infected were those whose primary vaccination had not for one or another reason been carried out, or whose re-vaccination had been performed at a comparatively distant period. Dr. Wutzdorff also told me that occasionally small-pox cases, not diagnosed at first as such, had been admitted to wards or pavilions in a general hospital and had spread the infection to unprotected persons coming into relation with them. At Berlin several instances of this kind had recurred both at the Charité and at the Friedrichshain hospitals during the last few years, as will presently be seen. In the opinion of Dr. Wutzdorff and other medical authorities with whom I conferred, the immunity from small-pox displayed by the people residing in and around a general hospital, when that disease was being isolated there, is entirely due to the almost complete antecedent protection of the population by compulsory vaccination and re-vaccination.

There are, it seems, no general instructions issued by the Central Health Authority to the local authorities of towns and districts in Germany as to the construction and administration of small-pox pavilions. Each municipality makes its own arrangements for the isolation of small-pox under the advice and direction of its Chief Medical Officer.

There appeared a general consensus of opinion that a considerable proportion of the small-pox cases now met with in Germany were in the persons of foreigners: especially Russians, Austrians, and Italians, many of whom come to Germany to work in new industrial undertakings, or as labourers on the construction of railways or on other public works. Many of the outbreaks of small-pox reported in Germany occur in towns and districts situated on or near the Russian or Austrian frontiers, especially the former. There are considerable commercial communications between some large towns in Germany and Russia, and small-pox has been observed in Russian commercial men visiting Berlin and other places in connexion with their business. Further, Russian and other emigrants passing through Germany on their way to Hamburg or other ports, by rail, have been known to infect persons whose duties, as railway officials for example, caused them to visit the trains, or who otherwise came casually into contact with these travellers.

Importation of small-pox infection into Germany has now and again been attributed to receipt from abroad of infected articles which had been contaminated through being handled by persons suffering from the disease, or which had been made in dwellings where small-pox was present. Lastly, infection has been brought by means of shipping from foreign countries to the larger German ports, such as Hamburg and Bremen.

BERLIN

Sketch Map of the site of the **BERLIN ROYAL CHARITÉ HOSPITAL** *and its surroundings*
The small-pox pavilion is shown in Red
The space within the dotted red lines (- - -) is where certain infectious diseases are isolated & which is enclosed by a low open iron fence
The Railway which forms the boundary of the South Western part of the site is marked

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The following table gives, for purposes of comparison, the number of recorded deaths from small-pox in Germany and in England during the 12 years 1891 to 1902 inclusive :—

Country, and Date of Census.	Population.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	Total in Years.
Germany (1900) ..	56,367,178	49	106	157	88	27	10	5	[redacted]	38	49	66	15*	607
England and Wales (1901).	32,526,075	49	431	1,457	820	223	541	25	253	174	85	242	2,461	6,761†

* The number of small-pox deaths for 1902 has been supplied to me from the Central Imperial Health Office at Berlin subject to any slight corrections which may be found necessary when the Medical Statistics for 1902 are issued officially

† There were 754 deaths from small-pox in England and Wales during 1903, but I have been unable to obtain the corresponding figures for Germany for that year

A brief description of the accommodation provided for small-pox isolation in the ten towns I visited is given below, and, where available, a map, plan, or diagram,* showing the site of the hospital or the arrangement of the buildings on the site, with the relations of the small-pox pavilion to the other hospital ward blocks or pavilions, is appended.

PRUSSIA.

Berlin has an estimated population† of 1,998,146. Small-pox cases occurring here are removed for isolation to the Royal Charité Hospital, which is situated on a site comprising 18 hectares‡ of land in the north-western part of Berlin, in a fairly populated district (see map appended). The Charité is the largest general hospital in Berlin and has about 1,500 beds. Connected with the Charité is the Medical School of the Berlin University, including the well-known Pathological Institute, attended by large numbers of students and medical men. At the Charité are received a considerable variety of cases, surgical and medical, including persons suffering from infectious diseases. For the latter three pavilions are provided, one of which, divided into two wards, with a total accommodation of 12 beds, is reserved for small-pox. This small-pox pavilion, as may be seen by a reference to the map, is not shut off from the rest of the hospital save by a low open iron fence (marked by a dotted red line on the plan annexed), easily surmountable, which surrounds that portion of the site on which stands the pavilions for infectious disease. The small-pox pavilion is only about 24 feet from one of the pavilions used for isolation of scarlet fever, and only about 150 feet from the southern boundary wall of the establishment which abuts on the

* For much valuable assistance in the preparation of the appended maps, plans, and diagrams, I am indebted to Messrs. Besley and Hunter, of the Medical Department.

† These estimates of population for the towns visited by me are taken from the December issues of the "*Veroffentlichungen aus dem Kaiserlichen Gesundheitsamte*," published weekly at Berlin.

‡ A hectare equals 2·471 acres.

* A No If the allegations Germans for isolation small-pox as by Dr Bruce Low.

stand. When a case of small-pox is admitted the nurses and other staff told off for the small-pox pavilion are re-vaccinated by one of the hospital assistant medical officers: there is no general re-vaccination of the rest of the staff of the hospital or of the patients in the medical and other wards. There exists in connexion with the pavilions for infectious diseases a small separate block for the accommodation of nurses engaged in waiting on this class of cases, so that the small-pox nurse or nurses does not sleep in the general nursing block: the cooking, however, for the small-pox patients and for the small-pox nurses is done at the central kitchen, whence the food is brought to the special pavilion. The washing of soiled linen, &c., after certain precautions have been taken, is effected at the hospital central laundry. When small-pox is admitted to this pavilion at the Charité it is usual, I understand, to remove as early as possible the patients from the adjoining pavilions to some other part of the hospital. I was informed by General-Arzt Schuppel (Geh. Ob. Med. Rat., who is the Chief Medical Director of the Charité, that reliance is placed upon the previous vaccination and re-vaccination of the population, including the patients in the hospital, to protect them from the possible spread of the infection from small-pox cases treated on the site of the Charité. He added that but for statutory vaccination and re-vaccination it would be necessary to find a site in the country, away from the town population, where small pox cases might, without danger to others, be isolated. He was very strongly of opinion that it is the universal vaccination and re-vaccination of the community that prevents small-pox from spreading, and that without the practice in question the whole system of isolation of the disease in Germany would have to be completely changed, which would involve enormous expense to the ratepayers. As matters stood the officials of Berlin had no fear of bringing small-pox cases into the Charité, and it was rare that any spread of disease took place from the small-pox pavilion. When such occurred, it was mainly among unvaccinated persons, or among persons whose re-vaccination had been performed at a comparatively distant date, and whose protection, therefore, had worn out.

On examining the recent small pox statistics of Berlin up to the period for which published details were available at the time of writing, I find that during the seven years from 1895 to 1901 inclusive, outbreaks occurred in each year except two (viz., 1896 and 1900), and that in each outbreak the origin of the infection was traced to foreigners. Russians, Italians, Austrians, Portuguese, and in one instance to a group of performing negroes from England in German West Africa. In all, some 70 cases were imported in the seven years period just referred to; only nine of the cases were fatal.

A very interesting group of cases five of which were fatal, occurred in 1895 to which my attention was specially drawn by Dr. Wutzdorff, the courteous Secretary of the Central Imperial Health Office. This group resulted from the admission of an unrecognised case of small-pox in an unvaccinated child,* aged 8 to the large general hospital at Friedrichshain (800 beds or more) in the

* The mother stated that the child was unsuccessfully vaccinated on two occasions.

suburbs of Berlin. Three days later the girl died, and on the same day her infant sister, aged 3 months, sickened with what was thought to be chicken-pox. She also was removed to the general hospital at Friedrichshain. In her case small-pox was diagnosed on admission, and in consequence the infant was at once removed to the small-pox pavilion at the Charité Hospital, where she speedily died. Starting from these two cases, a localised outbreak occurred at the Friedrichshain Hospital among patients who had been inmates of, or who had had relation with, the pavilion in which the two children had for a while been nursed. These cases were: (1) an unvaccinated scarlatina convalescent, aged 9; (2) an unvaccinated measles convalescent, aged 2; (3) a whooping cough convalescent, aged 3½, who also had never been vaccinated. These three attacks all proved fatal. (4) A woman, aged 31, convalescent from diphtheria, and who had been treated in the block to which the two first cases had been admitted; (5) one of the nursing staff, aged 22, who had been in relation with some of the previous cases; (6) a ward maid aged 30, employed in the same pavilion as the previous case. The diphtheria convalescent aged 31, had been re-vaccinated 19 years previously; the nurse's re-vaccination had proved unsuccessful; and the ward-maid had never been re-vaccinated at all. The small-pox attack in each of these three adults was mild. Later, a further crop of cases of small pox developed in the Friedrichshain Hospital, viz., (7) a male servant, aged 21, who had some duties to perform in the pavilion to which the early cases had been brought before removal to the Charité; he had been vaccinated in infancy, but unsuccessfully re-vaccinated in boyhood; (8) a medical student at that hospital, aged 24, vaccinated in infancy, but unsuccessfully re-vaccinated in boyhood; (9) and (10) two other medical students, colleagues of the former, aged respectively 22 and 23, both vaccinated in infancy and re-vaccinated in boyhood.* (11) A workman, aged 36, employed in the hospital, vaccinated in infancy and re-vaccinated at the age of 12.† This man had never been in the pavilion where the other cases had been treated, but prompted by curiosity had ventured close to the door of the particular pavilion to see some of the small-pox cases that were being removed to the Charité. The three medical students were present in the mortuary when the body of the first child who had died from unrecognised small-pox was examined. All of these five last mentioned Friedrichshain cases had the disease in a mild form.

It deserves mention that the source of infection of the two first cases which started the outbreaks in the Friedrichshain and Charité Hospitals was traced to a lodger, a Russian, who was staying temporarily at the house of the parents of the two children earliest affected. This Russian suffered from "pimples" on his face for which he sought treatment at the out-door department of the Charité, where his disease was at first diagnosed as "Urticaria Variolæformis Universalis." A student, aged 23, at the Charité, who was attacked by small-pox a fortnight later, was regarded as having been infected by the Russian patient in the waiting room. This student had been vaccinated in infancy and re-vaccinated in boyhood, and unsuccessfully re-vaccinated on entering the army. Another student, also aged 23, developed small-pox a fortnight after paying a single visit to the pavilion at the Charité where some of the Friedrichshain patients were being isolated. He had been vaccinated in infancy, but his re-vaccination in boyhood was unsuccessful. Both students had mild attacks. Lastly, to the group of cases traced to the Russian, there has to be added that of an unvaccinated boy aged 4 whose mother had lent the mother of the two first cases a sofa on which the children had lain before they were removed to the Friedrichshain Hospital. This boy was attacked after the sofa was returned to his mother. When he fell ill he was taken to the Charité, where he had a severe attack of confluent small-pox, and barely escaped with his life. His eyesight, however, was permanently damaged.

Thus, from the Russian lodger, small-pox directly or indirectly spread to 16 persons, 10 of whom were adults, all vaccinated in infancy and some of whom had been re-vaccinated, all of these adults recovered, none of their attacks having been severe. The remaining six were children, whose ages varied from

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* These students were re-vaccinated when it was recognised that small-pox had occurred in the hospital, but they had already received the infection, and their re-vaccinations were unsuccessful.

† He was also re-vaccinated along with other members of the hospital staff when small-pox was diagnosed in the first group, but he had already been infected, and had passed through a portion of the incubation period of small-pox, so that his latest re-vaccination was too late to check his attack.

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On the arrangements in Germany for the isolation of small-pox cases, by Dr. R. Bruce Low.

three months to nine years; none of them had been successfully vaccinated; five of them died, and the sixth narrowly escaped death, but had permanent injury of his eyesight. In the family first attacked, and where the two unvaccinated children died, the only other child of the family, aged five years, had been vaccinated as an infant, and though exposed to the small-pox infection in a very marked degree, escaped entirely. In the family where the unvaccinated boy was attacked after the return of the infected sofa, there were three other children, all of whom had been successfully vaccinated: these children, though exposed to the same infection as their unvaccinated brother, escaped altogether."*

In this connexion, regarding the spread of small-pox in the Berlin Charité to persons who had not been previously protected by re-vaccination, reference may be made to the experience of Professor Weintraud of Wiesbaden, while acting as resident medical officer at the Charité, *see* page 229.

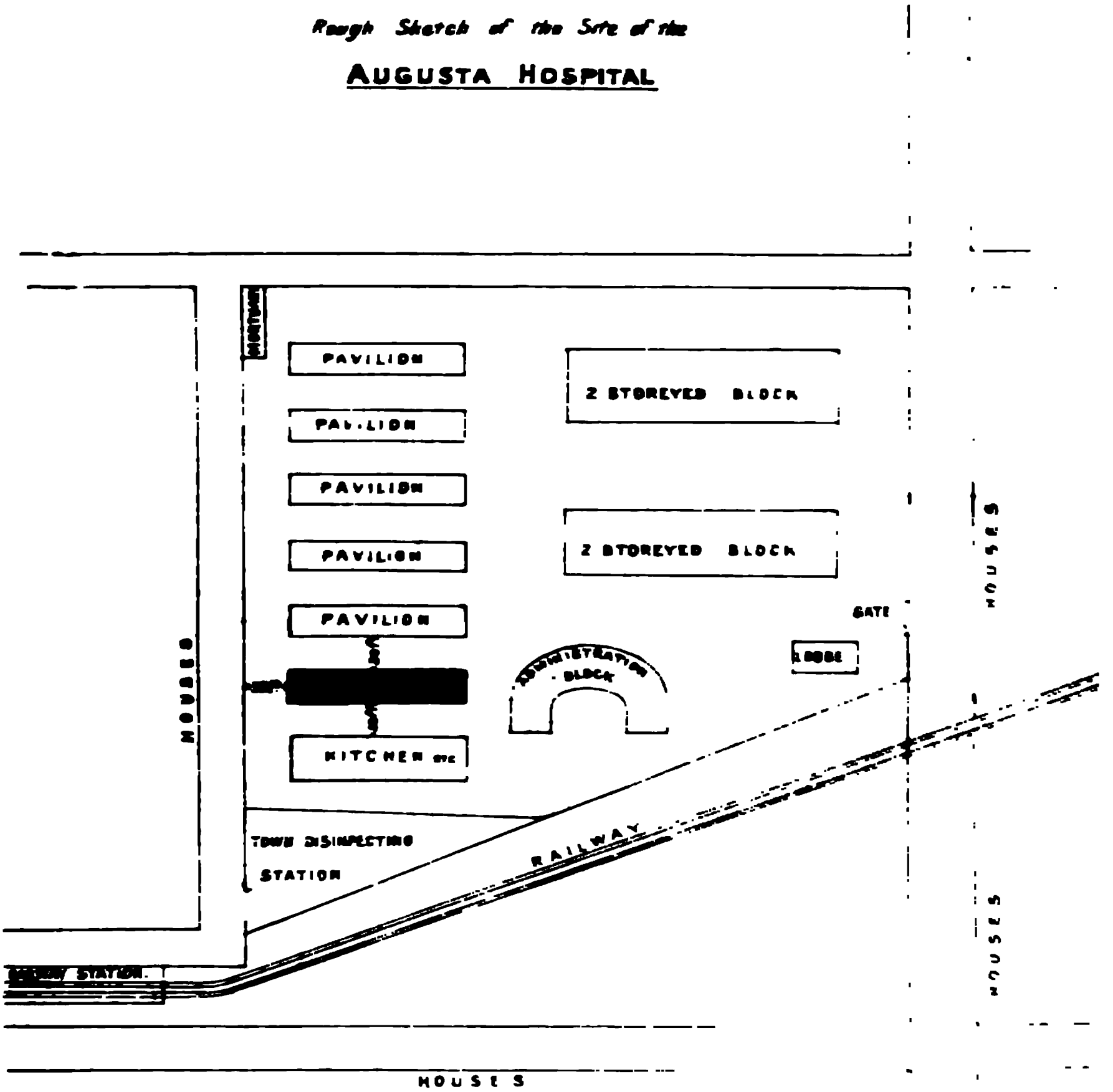
Cologne has an estimated population of 399,126, and is a city of great importance, commercially and otherwise. The occasional cases of small-pox imported into Cologne are isolated at the Augusta Hospital, which is situated in the north-eastern suburbs of the city. The site is trapezoid in shape, and on two sides it is overlooked by rows of four-storeyed buildings; on the third side runs a railway embankment; and on the fourth are some forts occupied by soldiers. At one corner of the site, but shut off from it by a high wall, is the city disinfecting station. The site is enclosed by a brick wall nine feet high. The hospital has accommodation for 575 beds for medical cases (no surgical cases are admitted, there being two other hospitals in the town), including 100 beds for cases of infectious diseases, such as scarlet-fever, measles, and small-pox. A hundred beds in a special pavilion are reserved for tuberculosis cases in advanced stages of the disease. Tuberculosis patients in less advanced stages are treated according to modern open-air methods at a sanatorium outside the town. Nursing at the Augusta Hospital is by Sisters of Mercy. There is no separate pavilion for small pox; when a case is notified a pavilion is at once cleared of its patients by removal of them to some other part of the hospital. The nurses and other members of the staff likely to be brought into relation with the small-pox case are at once re-vaccinated. I was shown the pavilion usually selected for the isolation of small-pox at the Augusta Hospital. It contains two large wards, each with 17 beds, and three small private or observation wards each with two beds—40 beds in all. There is also a kitchen, scullery, and bathroom; the closet accommodation is at either end of the pavilion. There is in addition a sleeping apartment for the nurses. This small-pox pavilion is situated about 30 feet from the nearest adjoining pavilion, and about 35 feet from the boundary wall. It is about the same distance from the main hospital kitchen and a little further from the central administrative block (*see* diagram plan of site appended). When I visited the Augusta Hospital I was met by Professor Minkowski, the Chief Physician, who was good enough to explain the details of the method adopted in Cologne for isolating small-pox. There had been no instance, so far as he knew, of spread of infection from the pavilion. He expressed the opinion that the German immunity from small-pox was due to

* Medizinal-Statistische Mittheilungen aus dem Kaiserlichen Gesundheitsamte; Band iv. Ergebnisse der amtlichen Pockentodesfallstatistik im Deutschen Reiche vom Jahr 1895, nebst Anhang "Die Pockenerkrankungen im Jahre 1895."

COLOGNE

Rough Sketch of the Site of the

AUGUSTA HOSPITAL

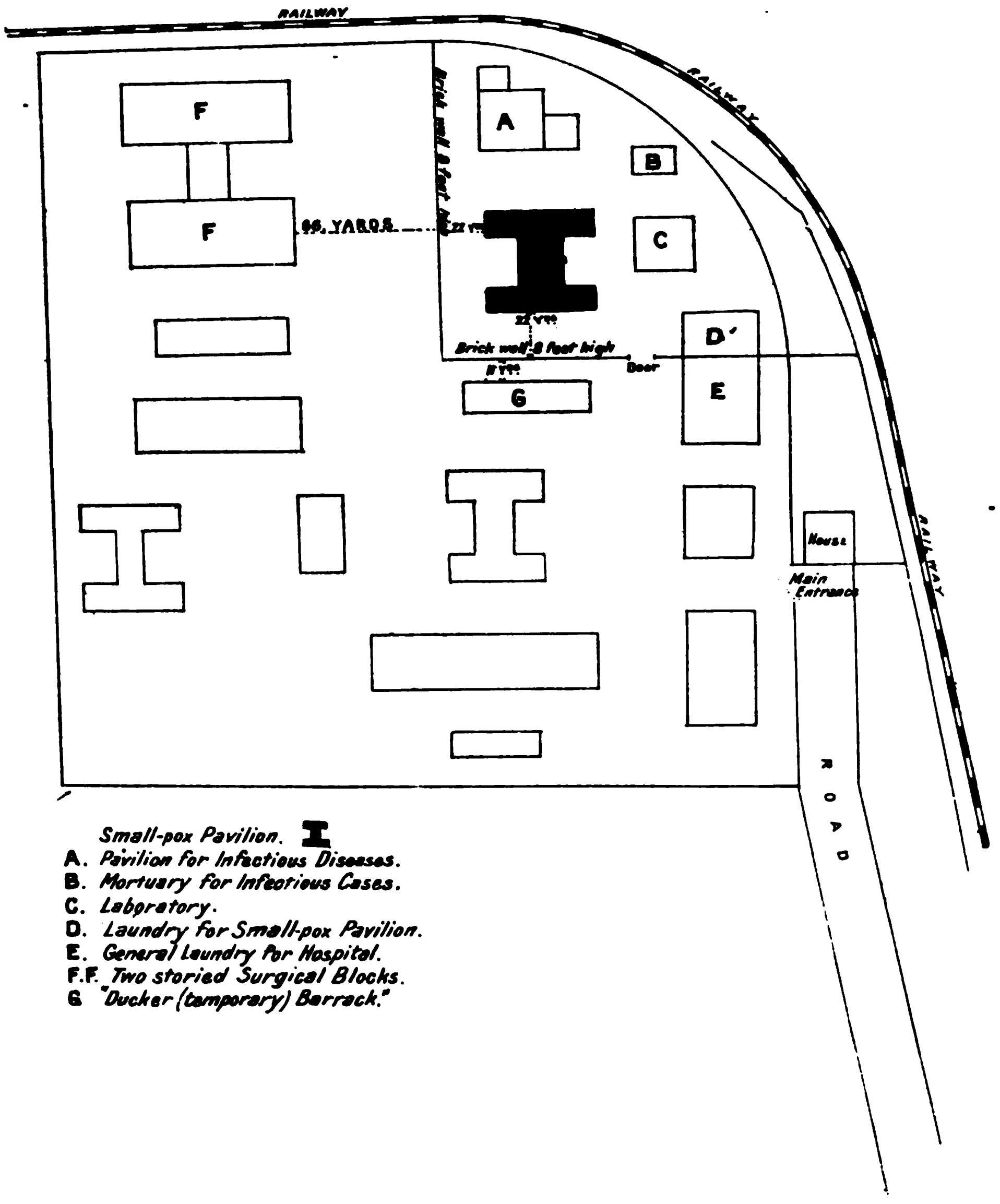


FRANKFORT-ON-MAIN.

Rough Sketch of the Site of the

GENERAL HOSPITAL

Showing the portion (enclosed by a wall) on which Small-pox Cases are isolated.



Small-pox Pavilion. I

A. *Pavilion for Infectious Diseases.*
B. *Mortuary for Infectious Cases.*
C. *Laboratory.*
D. *Laundry for Small-pox Pavilion.*
E. *General Laundry for Hospital.*
F.F. *Two storied Surgical Blocks.*
G *"Ducker (temporary) Barrack."*

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general compulsory vaccination and re-vaccination; it could not, he asserted, be attributed to the German method of isolation, which, he pointed out, would completely fail if it were carried out among a population which had not received the practically complete protection conferred by statutory vaccination and re-vaccination.

I also conferred with Dr. Meder, the Medical Officer of Health for Cologne, who agreed with the above opinions expressed by Professor Minkowski. There had occurred, he said, but few small-pox cases in Cologne, notwithstanding the many foreigners who visit the city for business or pleasure. Only one case of small-pox had come under notice in Cologne during the last ten years.

There had been some discussion among the authorities at Cologne with regard to the provision of a hospital site on the outskirts of the city for the isolation of imported cases of cholera or plague; but I understood that it was not intended at present to isolate small-pox anywhere else than at the Augusta Hospital.

Frankfort-on-Main has an estimated population of 311,410, and is a town of considerable commercial importance, being visited by many foreigners. When small-pox cases occur in Frankfort they are isolated at the General Hospital, which is situated on the outskirts of the town on the south side of the river Main, which hospital has a total accommodation of 850 beds, 50 of which are reserved for infectious cases. Frankfort has been somewhat fortunate, so far, in escaping from fatal outbreaks of small-pox; from 1892 to 1902 nine fatal cases have been reported, viz., five in 1893 and four in 1900. On the first of these occasions the infection was brought by workmen from the Russian border, and on the last it was believed to have been imported by a Russian Pole.* The outbreak of 1900 occurred coincidentally with a strike among local joiners; one of the foreign agitators who attended a meeting is believed to have introduced the infection. Two cases were notified in 1901 in the persons of two Mormons who had arrived in Frankfort from America. Neither of these persons had ever been vaccinated. In the outbreak of 1900 there occurred altogether 26 cases in Frankfort and neighbourhood.† These were isolated on the site of the General Hospital in a pavilion, which, though used commonly for other diseases, is emptied for the reception of small-pox as soon as a case of that malady is notified. This pavilion is subdivided into two large and several smaller wards for classification of the cases. A second pavilion adjoining can be used also for small-pox if the outbreak assumes larger proportions. There is a separate laundry and mortuary for the portion of the hospital set aside for infectious diseases, and the part of the site on which the small-pox cases are isolated is surrounded by a brick wall some 7 or 8 feet high, with a single entrance, which, when small-pox is

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* Bericht über die im Sommer, 1900, beobachtete Blatterepidemie Von Dr. M. Kaufmann. Münchener Med. Wochenschrift No. 50, 1900.

† *See also* Pockenepidemie in Frankfurt a/M., von Geh. San. Rat., Dr. Grandhomme, Kreisphysicus in Frankfurt a/M. Zeitschrift für Medizinalbeamte, Heft 4, 1901.

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being treated on the site, is kept locked: so that in this way the small-pox pavilion is shut off from the rest of the hospital. The nurses and others of the staff detailed for service in connection with the small-pox patients are at once re-vaccinated, and the Assistant Medical Officer in charge, as well as the nurses, lives within the walled-in area. This, I was informed, is deemed necessary solely in the interests of those patients in the general hospital who may have, for one or another reason, escaped statutory vaccination or re-vaccination. It is known to the medical staff that when foreigners, such as Russian Poles, Italians, or Austrians are admitted to the general wards for medical or surgical treatment they are frequently found not to have been vaccinated or re-vaccinated.

I conferred with Professor von Noorden, Chief Medical Officer to the Frankfort Hospital, and learned from him and from his senior assistant that so far as their experience went no spread of small-pox had taken place from the isolation pavilion to any member of the staff, or to any other person in the hospital. They had complete confidence in the vaccination and re-vaccination already undergone by the general population to prevent the spread of small-pox to patients when cases of this disease were admitted to the general hospital.

It may be added that the portion of the hospital site which is enclosed by the brick wall is somewhat triangular in shape, and is at its base 130 metres long, and is of similar length. The railway line forms, roughly speaking, the third side of the triangle. Within about 200 feet of the small-pox pavilion is a large two-storeyed block for surgical cases. (*See* diagram appended.)

I had the advantage of an interview with Geheimer Sanitätsrat Dr. Grandhomme, who is Medical Officer of Health for the City of Frankfort-on-Main, and who is also one of the public vaccinators for the town. Dr. Grandhomme assured me that he had every confidence in the method adopted in Frankfort for isolating small-pox cases; these cases, he added, were, in almost every instance, the result of foreign infection, imported into the city. He placed statutory vaccination and re-vaccination in the forefront of all current protective measures; without these he would have little hope of checking the onset of an epidemic.

Wiesbaden (estimated population, 92,301).—The General Hospital is situated on high ground to the north of the town, but is practically surrounded by houses. It has accommodation for 300 patients in six pavilions or ward blocks, some of which are two-storeyed. The arrangement of these blocks, and of the administration buildings, mortuary, laundry, &c., can be seen on the appended map. The provision for small-pox consists of a wooden pavilion with 16 beds in two wards. This pavilion is only 13 yards distant from the nearest hospital block, containing some 40 beds, and is about the same distance from the boundary wall. When last used for isolating 12 cases of small-pox, about 11 years ago (since then there has been no small-pox in Wiesbaden), it was administered as regards cooking and nursing from the same

Map of

[illegible]

WIESBADEN

showing site of the GENERAL HOSPITAL and position of the Small pox Pavilion thereon

buildings as the rest of the hospital, and no extension of infection occurred from the pavilion to anyone in the hospital or in its neighbourhood. All persons whose duties brought them in relation to the small-pox pavilion were re-vaccinated.

At the time of my visit the pavilion was occupied by non-infectious medical cases.

At an interview with Professor Weintraud, the Chief Physician to the hospital, and with his senior assistant, Dr. Wolff, both assured me that they placed their chief trust in statutory vaccination and re-vaccination to prevent the spread of small-pox, and that it would be impossible to isolate such cases on the site of the Wiesbaden General Hospital had not the population undergone vaccination and re-vaccination.

Immediately opposite the small-pox pavilion, on the other side of the street, is a very large public elementary school from which, at noon, one day while passing, I saw hundreds of children trooping forth into the street. To the south-east of the hospital site, and facing it, is a large orphanage. In conversation with Professor Weintraud I learned that he had advised the Municipal Authorities that there would be advantage in procuring a site outside the town, where cases of plague, cholera, or small-pox might in future be isolated. He explained to me that as regards small-pox this advice was not given by him owing to fear that this disease would spread if treated on the old hospital site, but with a view of meeting possible objections of people who might demur to be themselves removed, or to allow their relatives to be removed, to hospital while suffering from illness such as enteric fever, on account of the presence of small-pox cases in some adjacent pavilion on the grounds of the General Hospital. He affirmed that it was solely to meet this sentimental objection that he had suggested the provision of another site, which while held in readiness for exotic disease could be utilised for small-pox. Till that new site was provided he would continue to treat small-pox cases at the General Hospital, and he intended, if such cases occurred, to erect at once a small *Ducker* hut in which to accommodate them. The wooden pavilion formerly used he regarded as not now suitable.

Professor Weintraud in emphasising his perfect confidence in statutory vaccination and re-vaccination as a prophylactic against small-pox, gave me in illustration several instances which had come under his own observation. Among them, he mentioned the following. While resident medical officer some years ago at the Berlin Charité Hospital, two small-pox cases were admitted for isolation. For some time there had not occurred opportunity for demonstrating to the students the clinical characters of small-pox. Accordingly he was deputed by the chief physician to instruct in the diagnosis of small-pox some 260 students, in detachments, by the bedside of these two patients. As vaccination and re-vaccination are compulsory in Germany, it was not thought necessary to make inquiries as to this matter in regard of each student. But at the end of 12 days two students out of the 260

Ground Plan of the
MUNICH GENERAL HOSPITAL
SCALE
A Small-pox pavilion (shown in red)
B General Laundry & Boiler House &c
C New blocks for Nerve & Mental Diseases
D Nursing Home for the Sisters of Mercy
E Main Medical Block
F Residence of Professor von Bauer, Chief Medical Officer
G Childrens Wards
H Scarlet fever pavilion
J. Diphtheria
K. Surgical blocks
L Medical school buildings
M Deaf & Dumb institute
N Central Vaccinium institution
O Administration & Dispensary
P Mortuary

In the event of a genuine small-pox case being brought to this Gonsenheim hospital, not only would, I was informed, the precautionary measure of re-vaccinating the nurses and other persons whose duty brought them in relation with the hospital, be adopted, but all the convalescent patients would be at once sent away to their homes.

It is noteworthy that Mainz is the only town in Germany visited by me where provision for the isolation of small-pox has been made on a separate site. In one or two other instances, it is true, it was stated that proposals had been made to obtain outside the town a site where small-pox patients could be treated at a distance from the general hospital; but at the date of my visit nothing had been actually done in this direction, the only accommodation provided for such cases was still on the sites of the general hospitals.

At Mainz, as has already been mentioned, I had not the opportunity of conferring with any members of the hospital medical staff, and had consequently to content myself with the information supplied to me by lay members of the administration.

BAVARIA.

Munich, the capital of the kingdom of Bavaria, had at the end of 1903 an estimated population of 544,714. Its general hospital is situated near the centre of the city (see map appended) and has accommodation for 1,320 patients, medical and surgical, as well as for persons suffering from infectious diseases, such as scarlet fever, diphtheria, and small-pox. The 1,320 beds are distributed in a number of blocks and pavilions; and the arrangement of the hospital and administrative buildings upon the site is shown on the appended plan.*

The single pavilion which is reserved for the isolation of small-pox cases contains 14 beds. These are in eight small apartments, four of which contain one bed, two contain two beds, and two three beds. The pavilion is divided into two equal parts, each completely shut off from the other and having separate entrance. Each division has accommodation for a nurse and is provided with a small kitchen, a bath room, a lavatory, and a w.c. Upon occasion "contacts" have been accommodated in one division of the pavilion while the small-pox cases were being isolated in the other. This pavilion is surrounded by an open fence, eight or nine feet high, through which it would be easy to pass the hand, and on the top of which is a row of barbed wire to prevent anyone climbing over it. The fence is only about nine feet from the pavilion.

The building in closest relation with the small-pox pavilion is the hospital laundry, which at its nearest point is only about 17 yards distant. To the south of the small-pox pavilion and situated

* I am indebted for this plan to the Chief Director of the lay administration of the Munich General Hospital.

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from 55 to 70 yards away, are several other pavilions in which cases of scarlet fever, diphtheria, &c., are isolated. About 80 yards distant, but surrounded by a high wall, is the home of the Sisters of Mercy, to whom is entrusted the nursing of the patients in the hospital. The block about 90 yards to the north of the small-pox pavilion and the laundry is of recent construction and has been erected for the reception of cases of nervous and mental disease. The arrangement of the other buildings on the site will be seen on referring to the plan. It may be added that the small-pox pavilion stands about 50 yards from the boundary wall which abuts upon the roadway, on the other side of which is situated a large institute for the deaf and dumb. From this description it will be seen that the small-pox pavilion in the Munich General Hospital grounds is encompassed at no great distance by buildings accommodating a considerable number of persons. I had an interview with Professor von Bauer, the Chief Medical Officer of the medical section of the hospital, and his chief assistant, Dr. Hermann Kerschensteiner, and from these gentlemen I learned that when a case of small-pox is admitted to the pavilion it is the rule to re-vaccinate the medical nurses, though not those in the surgical and other parts of the hospital. The medical assistant who is detailed for attendance on the small-pox case is also re-vaccinated as a precautionary measure, although he may have been repeatedly re-vaccinated on previous occasions. I was assured that chief reliance was placed upon the fact that the persons coming into contact with the case had been all re-vaccinated; that practically all persons in the hospital and neighbourhood had submitted to the statutory vaccination and re-vaccination required by the German Law of 1874. It would be, these officers informed me, impracticable to isolate small-pox in the pavilion if the resident population in the hospital and neighbourhood had not acquired immunity to the disease through vaccination and re-vaccination. In no instance within the knowledge of these two gentlemen had infection spread from the small-pox pavilion to anyone in the hospital or its vicinity.

This small-pox pavilion at Munich is not used, as in most of the other German towns I visited, for the accommodation of other medical cases when not required for small-pox. It remains in charge of an elderly servant who keeps it clean and in readiness for use at a moment's notice. It can hardly be said to be administered, when in use for small pox, entirely apart from the general administration of the hospital; for although there is a small kitchen where cooking is done, part of the food must necessarily come daily from the central kitchen: Moreover, while the two nurses in charge of the sick sleep in the special pavilion, the medical attendant occupies quarters in the general hospital. Again, the soiled linen, &c., after being steeped in a disinfecting solution is sent to the general laundry to be washed before being returned to the pavilion. There is nothing to prevent persons who are walking in the hospital grounds from approaching close to the fence which, as has been said, is only nine feet from the small-pox pavilion.

From the annual official reports "Medizinal-Statistische Mittheilungen aus dem Kaiserlichen Gesundheitsamte" for the

Munich.

Map of the Central portion of the City of Munich shewing the site of the General Hospital on which cases of small-pox are isolated

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State & Municipal Buildings

Private Houses

Gardens & Laid-out grounds

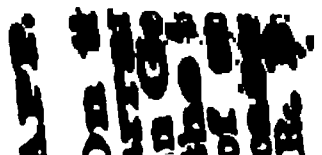
Railways

Tramways.

Scale 1 5000

250 500 1000 metres

5369 2 65



GROUND PLAN OF THE GENERAL HOSPITAL AT NUREMBERG

SHOWING DISTRIBUTION OF THE BUILDINGS ON THE SITE viz.

1. Administration
2 3 12 14 15. and 32 two storeyed large ward-blocks
4 Operating theatre
5 11 16 and 17 One storeyed large ward blocks
6 7 8 9 and 18 Detached small pavilions
10 Special ward block
13 Bathing establishment
19 Special block for male Syphilis cases
20. Ditto Ditto for female " "
21. Block for Mental diseases
22 Boiler house
23. Administration buildings containing central kitchen laundry &c
24. Mortuary
25 Gatekeepers Lodge
26. Residence of the Chief Medical Officer (Dr Merkel)
27. Workshops &c
28. Pavilion (in red) for epidemic diseases including Small-pox, 29. Small Dasker temporary pavilion 30 Medico-Mechanical Institute 31 33 34, 35 36 & 37 future extension building sites.

years 1896 to 1902 I find that only seven cases of small-pox have occurred in Munich during that period, viz., none in 1896, four in 1897, one in 1898, one in 1899, one in 1900, none in 1901, and none in 1902. Up to the end of November, the date of my visit to Munich, there had been no cases during 1903. So that in eight years Munich had required the isolation of only seven cases of small-pox, four of which occurred in one year.

Nuremberg has an estimated population of 294,819. The general hospital here, which has accommodation for 946 patients, is situated on a site of 10 hectares in the suburb of St. Johannis, to the north-west of the town. The buildings are of modern construction, having been opened as recently as 1897. Small-pox provision is afforded by a single pavilion (No. 28 on the appended plan*); this building contains 12 beds in two wards. There is accommodation for two nurses, and there is also a kitchen, a scullery, two bath rooms, and two closets. The small-pox pavilion is only about 14 yards from the boundary wall, which is about eight feet high; in the opposite direction it is about 27 yards from another wall of similar height, which surrounds the two syphilis blocks, which are distant about 44 yards from the small-pox pavilion (*see* plan). There is some open space to the west of the small pox pavilion, on which temporary buildings for the isolation of any epidemic disease could be speedily erected in case of need. I was informed by Medizinalrat Dr. Merkel (who is the Director of, and Chief Physician to, the general hospital) that there had been no small-pox in Nuremberg for about 11 years.

In the event of any outbreak occurring, the nurses† detailed to wait upon the patient or patients would be re-vaccinated, as well as the assistant medical officer who would be designated for attendance. There would be no general re-vaccination of the other nurses, officials, or patients in the rest of the hospital, reliance being placed on the previous vaccination and re-vaccination which is required by the law. The administration of the small-pox pavilion could not be entirely cut off from the rest of the hospital.

Dr. Merkel had no doubt that the immunity of the residents of Nuremberg from small-pox was due to the statutory vaccination and re-vaccination of the population. At the date of my visit the small-pox pavilion was being used for the accommodation of non-infectious medical cases; but in the event of a small-pox case occurring these other patients would be at once removed and accommodated elsewhere.

SAXONY.

Dresden.—The capital of the kingdom of Saxony had at the end of 1903 an estimated population of 518,405. It has two general

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* For this plan and for other information I am indebted to a report on the Nuremberg General Hospital by Herr Anton Schwab, Krankenhausverwalter, published at Nuremberg in 1903.

† The nursing at this hospital is mainly carried on by the Evangelical Lutheran Deaconesses.

hospitals, one comparatively old, the other quite new. The former is situated to the west of the city, in the suburb of Friedrichstadt; the other, recently opened, is in the eastern suburb of Johannstadt. It is at the Friedrichstadt Hospital that cases of small-pox occurring in Dresden are isolated. This hospital has accommodation for 1,058 medical and surgical cases, including 160 beds for infectious diseases. The latter are distributed in two two-storied blocks, one of which, with 80 beds, is reserved for scarlet fever; the second, used for other infectious diseases, is subdivided into four equal parts, each with a separate entrance and each having 20 beds. One of these subdivisions is kept ready for small-pox (*see* plan of hospital site appended). The scarlet fever block stands about 22 yards distant from and facing the second block, in the end subdivision of which the small-pox cases are isolated. The back windows of the small-pox wards face the boundary wall of the hospital site about 33 yards distant, and on the opposite side of the street and facing the small-pox wards is a line of three-storeyed houses.

When I visited Dresden, I conferred with Professor Adolf Schmidt, Medical Director and Chief Physician to the Friedrichstadt Hospital, and he kindly gave me detailed information as to the procedure which would be followed if a case of small-pox were admitted. He stated that the nurses and the assistant medical officer who would attend to the sick would be at once re-vaccinated. The nurses and doctor would have sleeping accommodation provided in the small-pox block, but food for them and their patients would have to be brought daily from the central kitchen. I was also told that if a case of small-pox were admitted, a temporary wooden closed fence, about 7 ft. high, would be erected round the outside of that portion of the block used for isolating the sick persons, so that visitors, or convalescents from other parts of the hospital, could not approach near to the small-pox building.

Professor Schmidt stated that his chief reliance against small-pox was placed on statutory re-vaccination, and that if the population residing in and around the hospital had not been rendered immune to small-pox by compulsory vaccination and re-vaccination it would be impracticable for cases of that disease to be treated on the site of the general hospital; that the authorities would be compelled to seek another site for the purpose, in the country, away from the town population. There was no record of small-pox having spread from the pavilion to the rest of the hospital or to houses in the vicinity. But he had as yet had no small-pox cases brought to the hospital since he had been appointed Director and Chief Physician. I was informed that there had been no deaths from small-pox in Dresden for the last 10 years.

In 1872 I myself visited the Friedrichstadt Hospital in Dresden at the time when a severe epidemic of small-pox had just passed over the city, and I then saw a number of small-pox cases being treated in extemporised pavilions within the hospital grounds. At my recent visit I was informed by a medical man of position (Hofrat Dr. Oscar Battmann, a prominent member of the City

DRESDEN

DIAGRAM PLAN OF

THE TOWN HOSPITAL

Scale, Metres.

0 100 200 300 400

Hospital Buildings

Small-pox Ward

Other Buildings

Gardens & Ornamental Grounds.

LEIPZIG.

Diagram Sketch of the Site of the Leipzig General Hospital (Städtisches Krankenhaus St. Jakob) and its surroundings

The small-pox pavilion is shown in red thus ▬ *The 4 pavilions within the red lines are those now enclosed for the isolation of Tuberculous patients, & which would be used upon occasion for small-pox if any considerable epidemic occurred in Leipzig*

To the North West of the Hospital site are situated the Buildings of the Medical School of the University of Leipzig

The large enclosed space to the East of the Hospital is a public Cemetery. And on the West of the site is one of the town Railway Stations

There is plenty of open space round about this Hospital site

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Council), who had practised in Dresden for more than 30 years, and in whose company I had visited the Dresden small-pox cases in 1872, that since the passing of the German law of 1874, which made re-vaccination as well as vaccination compulsory, there had been almost no small-pox in Dresden. Such cases as had occasionally been met with were in the persons of Austrians from Bohemia, the frontier of which is only some 30 miles from Dresden. There is no compulsory re-vaccination in Austria.

Leipzig has an estimated population of 484,838. Small-pox cases when they occur in Leipzig, are isolated at the general hospital (St. Jakobs Hospital) which is situated in the south-west suburbs of the town, close to the Bavarian Railway Station. The site has plenty of open space round it; and there is accommodation in the hospital for 1,450 patients, small-pox being treated in a pavilion containing 20 beds distributed in three wards, each of which has a separate entrance from without. This pavilion is situated only about 18 yards from an adjoining pavilion on one side, and about 20 yards from another pavilion on the other side (*see* plan of site appended). When the pavilion is to be occupied by a small-pox case the nurses as well as the assistant medical officer, who are to be in attendance on the patient, are re-vaccinated. Their food has to be brought to the pavilion from the general kitchen and left at the entrance. The nurses have sleeping accommodation in the pavilion. The assistant medical officer who has his quarters in the main administrative building, is required to wear a mantle over his clothing when he visits the wards, and is further required to remain at least half-an-hour in the open air after leaving the small-pox pavilion before he enters any of the other hospital or administrative buildings. When students (Leipzig is a University town) visit the small-pox pavilion they must previously submit to re-vaccination, whether or not the operation has been already performed on them. On the hospital site, enclosed by a closed wooden fence and situated to the east of the rest of the establishment, are four pavilions, accommodating 180 patients, occupied at present by persons suffering from tuberculosis of the lungs. I was told that if a small-pox outbreak in Leipzig threatened to assume considerable proportions, these tuberculosis patients would be at once sent to their homes, and that the four pavilions within the closed fence would be employed for isolation of the small-pox cases. During the eight years ending December, 1901, there had only been eight cases of recognised small-pox treated in the Leipzig Hospital; two of them were Russians and four were Austrians.

I was informed that small-pox had not been known to spread from the small-pox pavilion to pavilions adjoining it, nor had the disease attacked any person on the hospital site or those living in houses adjoining it.

When I visited this Leipzig General Hospital I had the advantage of an interview with Professor Curschmann (Geheimer Medicinalrat) Director of the Medical Clinic and Senior Physician to the St. Jakobs Hospital. From him I learnt generally that he placed re-vaccination in the first rank as a prophylactic against the spread of small-pox, being of opinion that isolation of cases

of this disease could not be carried out, in the manner adopted in Leipzig, without antecedent general vaccination and re-vaccination of the community. His view was that isolation alone would not suffice, but that, surrounded by a protected population, small-pox could be economically and efficiently isolated on the site of a general hospital. I also learned that Leipzig is regarded as somewhat specially exposed to the danger of importation of small-pox by Russians and other foreigners, as it is a great distributing centre for the fur and other trades; its fairs and business houses are visited by these foreigners; and merchandise fabricated in infected dwellings, or by infected persons is believed to be, at times, sent direct to Leipzig.

WÜRTTEMBERG.

Stuttgart, the capital of the Kingdom of Württemberg has an estimated population of 191,645. Accommodation for small-pox cases as also for cases of diphtheria and scarlet fever is afforded at the Katharine Hospital (*see* map appended). The total number of beds provided for medical and surgical cases at this hospital is 700; and these are distributed among a number of two-storeyed ward blocks and one-storeyed pavilions. The small pox pavilion is a *Ducker* hut or "barrack" which is divided into two wards, each with six beds; there is a room for a nurse, also a small kitchen, a bath-room, and two closets. This "barrack" which, when I saw it, was a little out of repair, as is almost unavoidable in view of the material of which it is constructed and the length of time it has been erected, stands close to the northern boundary of the hospital site. The building nearest to it is a block containing 30 beds in which syphilitic cases are treated, and which is situated only four yards away from the gable of the small-pox pavilion; a two-storeyed surgical block containing 50 beds is, at its nearest point, only eight yards from the small-pox pavilion, which again is only about 11 yards from the wire fence which separates the Katharine Hospital site from the grounds of the Stuttgart Lying-in Institute. This midwifery school and hospital has accommodation for 67 patients and 50 resident midwife-pupils. It is a three-storeyed building standing little more than 30 yards distant from the *Ducker* "barrack" in which small-pox cases have to be isolated.

I was unfortunately unable to see Ober-Medicinalrat Dr. von Landenberger, the Chief Physician to the Katharine Hospital when I was at Stuttgart, but I conferred with the Principal Assistant Medical Officer, Dr. Hartmann, who showed me over the hospital and gave me all the information I required. I learnt from him that there had been no cases of small-pox in Stuttgart for six years; the last person who suffered from the disease was a foreigner, a Russian. In Dr. Hartmann's opinion statutory re-vaccination was the main measure for preventing spread of small-pox; that without it isolation of small-pox cases on the site of the Katharine Hospital would be impracticable. Owing to the general immunity conferred upon the population by obligatory vaccination and re-vaccination small-pox was, in his view, unlikely to spread when brought to the hospital. Care would, of course, be taken whenever a case was admitted, to repeat the re-vaccina-

STUTTGART.

Sketch Map of the North Eastern portion of **STUTTGART.**

Showing position of the Katherin Hospital on the site of which Small-pox Cases are isolated.
The Small-pox Pavilion is shewn thus ■
The building immediately above the Small-pox Pavilion is the Lying-in- Institute

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tion of nurses and others whose duties brought them into close relation with the case or cases isolated in the *Ducker* barrack. Dr. Hartmann knew of no instance where a small-pox patient had spread infection when brought to the Katharine Hospital for isolation. He admitted that the provision for small-pox was of a somewhat rudimentary kind, but considered that it had proved sufficient for the wants of Stuttgart.

Such cases of small-pox as occur in the Kingdom of Württemberg are found, I learnt, usually among foreigners; the last cases reported were among a tribe of Bosnian gypsies who were travelling through the country with performing bears.

There has been no death from small-pox in the whole Kingdom of Württemberg since 1893, when two fatal cases were certified; and in the eight years preceding 1893, *i.e.*, from 1885 to 1892 inclusive, there occurred only three small-pox deaths, viz., two in 1886, and one in 1888. Thus in 18 years in Württemberg (from 1885 to 1901), (*see* Medizinal-Bericht von Württemberg für das Jahr, 1901, Stuttgart, 1903), there were no more than five deaths from small-pox in a population now estimated at 2,183,000.

To the 10 towns which I visited in the autumn of 1903 may be added another, viz., Hamburg, which I visited unofficially earlier in the year. At Hamburg, which has an estimated population of 747,167, small-pox cases are treated at the large new General Hospital at Eppendorf, which is situated in the suburbs. At this hospital there is accommodation for 2,000 patients, including medical, surgical, and infectious cases. Small-pox is treated in a pavilion in no way shut off by fence or wall from the other pavilions; is situated moreover close to one of the open roadways running through the site. On inquiry I was told that no trouble had been experienced through the spread of small-pox from this pavilion to persons living on the hospital site. Confidence is placed in statutory vaccination and re-vaccination to protect the patients in the hospital, while members of the staff who had to come into direct relation with the sick were submitted to further re-vaccination.

From the account above given of the methods employed in Germany for isolating small-pox it will be obvious that the general plan followed differs markedly from that employed in this country. Almost always, in Germany small-pox cases are isolated on the site of the general hospital, and, as often happens when the occurrence of small-pox in a given place is rare, the small-pox pavilion is not allowed to stand empty but is used for the accommodation of other cases, infectious or non-infectious. Untoward results to other persons, from bringing small-pox to the site of the general hospital for purposes of isolation and treatment have been seldom observed, and this, in Germany, is with one consent attributed to the protection which is conferred on the population by statutory vaccination and re-vaccination. Without these the German method, it is unanimously admitted, would break down.

It has been asserted in England by persons who have little or no faith in the value of vaccination as a prophylactic against

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small-pox, that the comparative immunity of the German nation from that disease is due, not to statutory vaccination and re-vaccination, but to the strict system of isolation of small-pox which is carried out in Germany. But the evidence given to me by the eminent medical men with whom I personally conferred, entirely refutes this assertion; and, one and all joined in the representation that compulsory vaccination and re-vaccination were Germany's great protectors against small-pox.

The description which I have given of the position of the small-pox pavilion at each of the hospitals visited in Germany shows conclusively that there is not in that country "strict system of isolation of small-pox" in the sense as we in England understand it. With one or two exceptions the pavilion is shut off in no way from the rest of the hospital, and there is no limitation in the number of persons residing within the several zones around the hospital. Nor is the administration of the small-pox pavilion entirely separate from the general administration of the hospital establishment. The German nation, therefore, by the agency of compulsory vaccination and re-vaccination is able to dispense with separate small-pox hospitals altogether. It is not necessary there to provide for small-pox a separate site nor separate administration. Germany is in this way freed from great expense, not to speak of the suffering and the inconvenience which fall upon the English nation.* But all this could not be achieved in Germany unless the Law of Compulsory Vaccination and Re-vaccination were thoroughly carried out.

Germany, indeed, would have less need even for small-pox pavilions on the sites of her general hospitals, than she has at present, were it not for the continual importation of small-pox by foreigners, or by German subjects returning from foreign countries.

Should Germany's Vaccination Law at any future time be carried out less efficiently than at present, she may not only have to face the inconvenience of having to isolate more small-pox cases, but may also be driven to provide separate accommodation for small-pox cases at a distance from populous areas, and to endure the further expenses of separate administration and the like.

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* For purpose of comparison I append a statement of the requirements of the Local Government Board as to small-pox hospital sites provided by means of loans sanctioned by them. The following is an extract from the Memorandum "On the provision of Isolation Hospital accommodation by Local Authorities" (1902):—

"*Hospitals for small-pox.*—In view of the frequently demonstrated liability of small-pox hospitals to disseminate that disease to neighbouring communities, and in order to lessen the risk of such occurrence, the Board require the following conditions to be complied with in the case of small-pox hospitals provided by means of loans sanctioned by them:—

1st. *The site must not have within a quarter of a mile of it either a hospital, whether for infectious diseases or not, or a workhouse, asylum, or any similar establishment, or a population of as many as 200 persons.*

2nd. *The site must not have within half a mile of it a population of as many as 600 persons, whether in one or more institutions, or in dwelling-houses.*

3rd. *Even where the above conditions are fulfilled a hospital must not be used at one and the same time for the reception of cases of small-pox and of any other class of disease.*"

No. 16.

App. A, No. 16. Summary of the Progress and Diffusion of Bubonic Plague in 1903 by Dr. Bruce Low.

Summary of the Progress and Diffusion of Plague throughout the World* during 1903 by Dr. R. Bruce Low.

INDIA.

During 1903 the ravages of plague in India, far exceeded those of any of the previous years in which the disease has been epidemic. The attacks reported amounted to 1,127,205, and the deaths to 865,747. In the subjoined tabular statement the data for each of the years from 1896 to 1903 inclusive are given.

Year.	Attacks.	Deaths.	Case mortality per cent.
1896	2,980	2,288	76·7
1897	73,655	55,548	75·4
1898	151,640	117,733	77·6
1899	176,155	135,996	77·3
1900	110,017	92,106	83·7
1901	362,750	283,778	78·2
1902	765,172	575,469	75·2
1903	1,127,205	865,747	76·7
Total in 8 years ...	2,769.574	2,128,665	76·8

The general behaviour of the disease in 1903 was similar to that observed in previous years, the maximum of cases being noted in March and April, and the minimum during the months of June and July.

As regards the incidence of plague on the several Presidencies, Provinces, and Native States, it may be mentioned that those chiefly suffering were the Presidency of Bombay, and the Punjab

* For convenience of reference an alphabetical index of the chief places and countries attacked by plague in 1903 is appended to this summary.

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the United Provinces of Agra and Oudh coming next. The figures for each Presidency, Province, or State are given below :—

Table showing the number of recorded plague attacks and deaths, the case mortality, and the rates of incidence per 1,000 of the population in the Provinces and States of India during 1903.

Presidency, Province, or State.	Population, census of 1901.	Plague.		Case mortality per cent.	Plague attack rate per 1,000 of the population.	Plague death rate per 1,000 of the population.
		Number of reported Attacks.	Number of reported Deaths.			
Presidency of Bombay (including Native States).	25,468,209	464,323	363,652	78·5	18·5	14·2
Presidency of Madras (including Native States).	42,397,522	16,553	13,291	78·8	0·4	0·3
Presidency of Bengal (including Native States).	78,493,410	74,265	65,680	88·6	0·9	0·8
United Provinces of Agra and Oudh (including Native States).	48,493,879	82,421*	80,729*	97·9	1·7*	1·6*
Punjab (including Native States).	24,754,737	341,267	210,697	61·7	13·7	9·5
Central Provinces (including Berar and Native States).	14,627,045	47,526†	51,514†	?	?	3·5†
Mysore State	5,539,399	29,375	22,291	75·9	5·3	4·0
Hyderabad State	11,141,142	33,908	28,094	85·8	3·0	2·5
Central India	8,628,781	33,162	26,169	78·8	3·8	3·3
Rajputana	9,723,301	2,718	2,442	89·8	0·3	0·2
Kashmir	2,905,578	1,190	1,053	88·4	0·4	0·3
North West Frontier ..	2,125,480	51	49	98·0	—	—
Baluchistan (including administered territory and Agency Tracts.)	810,746	4	3	50·0	—	—
Burma	10,490,624	31	9	61·5	—	—
Assam	6,126,343	37	28	77·8	—	—
Coorg	180,607	74	45	60·8	0·4	0·2
States, Islands, &c., not included above.	2,454,253	—	—	—	—	—
Totals	294,361,056	1,127,205	865,746	74·8	3·8	2·8

* Since the Table was drawn up, the Annual Report of the Sanitary Commissioner of the United Provinces for 1903 has been received, and this, though not stating the number of plague attacks for the year, gives the deaths as numbering 84,499. It is evident, therefore, that the figures in the table understate the incidence of plague in the United Provinces.

† The number of cases is compiled from the weekly summaries sent from India; the deaths are taken from the Annual Report of the Sanitary Commissioner with the Government of India for 1903, which, however, does not give the corrected number of cases. In the above table it is evident that the number of plague attacks in the Central Provinces is understated.

BOMBAY PRESIDENCY.

(Including the City of Bombay and the Native States.)

Plague continued to ravage this Presidency during 1903, the reported cases and deaths numbering no fewer than 464,323 and 363,652 respectively. This amount far exceeds anything that has been previously recorded in this Presidency, the highest figures in any former year being those of 1902, viz., 293,376 cases and 217,957 deaths. The behaviour of plague in the Presidency of Bombay since 1896 is shown in the Table below :—

Year.	Cases.	Deaths.
1896	2,980	2,286
1897	73,062	55,168
1898	135,572	105,311
1899	152,482	116,992
1900	49,131	[illegible]
1901	207,387	157,552
1902	293,376	217,957
1903	464,323	363,652
Total in 8 years ...	1,378,305	1,057,188

Thus over a million deaths have been referred to plague in this Presidency during the last eight years.

The course of the epidemic of 1903 is indicated by the subjoined tabular statement, which shows that though the disease greatly diminished during May and June, a fresh outburst developed in the autumn and continued to prevail with intensity during the last four months of the year.

Plague in Bombay Presidency.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Attacks	56,480	60,868	53,018	28,031	8,748	4,741	12,115	30,279	49,993	65,375	54,721	41,936	464,325
Deaths	45,456	47,521	40,793	21,896	5,574	4,004	9,929	25,055	39,435	51,027	41,979	33,264	363,652

82,483 of the plague deaths were referred to the Native States associated with the Bombay Presidency.

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The Collectorates which suffered the most severely from plague in 1903 were Dharwar (47,022 deaths) and Belgaum (45,021 deaths). The others largely suffering were Satara, Sholapur, and Ahmednagar with respectively 28,083, 25,238, and 21,447 deaths.

City of Bombay. Census population of 1901, 776,006.—Notwithstanding the energetic and carefully devised precautions which have been adopted in Bombay, plague continues year by year to ravage the city. The number of attacks and deaths from the disease recorded during 1903 was the highest for any of the past eight years during which plague has been present in the city, 23,344 cases and 20,788 deaths being attributed to this cause. The distribution of these cases and deaths during the several months of the year is shown in the subjoined Table. As in former years the height of the epidemic was reached in March.

Plague in Bombay City.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903
Attacks	1,206	3,959	6,571	6,362	1,719	728	399	384	363	300	248	315	23,344
Deaths	1,095	3,402	5,905	5,737	1,581	657	349	335	329	263	221	271	20,788

The case mortality rate was 89·1 per cent.

For purposes of comparison the returns for each of the years since plague invaded Bombay City are given below :—

Year.	Reported Plague—		Case mortality per cent.
	Attacks.	Deaths.	
1896	2,544	1,936	76·1
1897	13,314	11,003	82 6
1898	19,863	18,130	91·2
1899	19,454	15,874	81·6
1900	17,915	13,247	73·9
1901	20,885	18,694	89·5
1902	16,423	14,088	85·7
1903	23,344	20,788	89·1
In 8 years	133,742	113,760	85·0

Dr. J. A. Turner, Medical Officer of Health for the Municipality of Bombay, submitted proposals at the end of 1903 to the Government with a view to institution of careful continuous investigation respecting "the cause of, and the spread of plague, in all its bearings, from the infected to uninfected areas, and the measures to prevent it."* The following matters were suggested by Dr. Turner for special investigation, viz. :—

"(1.) Climatic conditions and their effect on the existence and vitality and propagation of plague.

(2.) Habits and customs of the people predisposing to the disease.

(3.) Habits and customs of the people tending to spread the infection ; disposal of the dead, funeral parties, exposure of infected persons or things.

(4.) Other human agency and its effect in spreading the disease.

(5.) Animal agency, parasites, rats, fleas, flies, and mosquitoes.

(6.) The existence of an organism outside the body, and its relation to an organism found in the blood and tissues of persons dying of plague. Its origin, mode of propagation, introduction into the system, and the conditions which favour its vitality, its possible presence in the air, dust, floors, sewage, food, and water ; its method of conveyance from man to man, from man to animal, and from animal to man."

In addition, Dr. Turner urged—

"The bacteriological examination of air, dust, clothing, &c., in infected rooms or places to which actual infection has been traced. Continued experiments with all and every organism found in infected rooms or localities and material, eliminating all known non-pathogenic bacteria by experiments on animals with a view of discovering what organism, if any, exists, and its morphological characteristic and life history, which may be the cause of the disease."

The Government of Bombay received Dr. Turner's proposals in a favourable spirit, but the matter had to be referred for decision to the Secretary of State for India, and at the time of writing it is not known what the final decision has been.

The Port of Bombay.

During 1903 the number of vessels entering or leaving the port of Bombay was 69,892, of which 14,597 were inspected. The number of plague cases discovered within the port was 77 (as compared with

* Extract from the Report of the Executive Health Officer, Bombay Municipality, on the control of plague in Bombay.

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44 in 1902). Of these 16 were referred to incoming vessels. One ship the s.s. *Khalif* (of the German East Africa Line) yielded nine plague cases. She arrived in Bombay harbour on March 14th from Zanzibar, *viâ* Marmagon, with a crew of 65 and three passengers. The Master reported that eight persons, including the third officer and a deck passenger, had died during the voyage, between March 4th and 11th, and had been buried at sea; and, that a coal trimmer on board was suffering from fever and a bubo. This man was landed at the hospital where his disease was diagnosed as plague; and it was inferred that the eight deaths referred to above had been due to plague. It is stated that on February 20th about 50 dead rats were found in the storeroom. The *Khalif* is believed to have become infected by plague while lying in Durban before she sailed for Zanzibar (*see* also under Zanzibar, page 285).

Another incoming ship, a transport, the *Satara*, arrived in February with one case of plague on board, another having died during the voyage. Some dead rats were found on board the vessel towards the end of February.

As regards departing vessels, medical inspection of the crew and passengers before sailing resulted in the discovery of 39 plague cases. While on native craft lying in the harbour 20 persons suffering from plague were found. It is also worth mentioning that the bodies of two dock labourers were discovered on the wharf, their deaths being attributed to plague.

The following table shows, year by year from 1897 to 1903, the number of vessels examined in the port of Bombay, the total persons, crew and passengers, inspected, and the number of plague cases discovered.

Year.	Vessels Examined.	Number of Crew and Passengers Inspected.	Number of Plague Cases Discovered.
1897	72,808	1,313,117	169
1898	71,498	1,207,571	236
1899	65,822	1,193,339	155
1900	65,966	1,173,050	84
1901	34,637*	886,310*	73
1902	15,432	701,964	44
1903	14,597	719,322	77

* Major Crimmin, V.C., I.M.S., Health Officer for the Port, accounts for the decrease in the number of vessels and persons inspected by the fact that vessels sailing from the port of Bombay for ports on the coast of the Kolaba district, as far south as Roha, were exempt from medical inspection in accordance with the Government Notifications of April 17th and September 30th, 1901.

Madras Presidency.

During 1903 there were reported in the Madras Presidency 16,853 cases of plague with 13,291 deaths, against 15,425 attacks and 12,603 deaths in 1902, and 915 cases and 685 deaths in 1901. The districts which chiefly suffered were Salem, Bellary, and North Arcot; the same districts that suffered the most in 1902.

The subjoined table shows, month by month, the number of notified cases and deaths from plague in the Madras Presidency during 1903 :—

Plague in the Madras Presidency.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Attacks	4,436	3,183	1,639	436	66	114	666	593	602	1,323	1,319	2,421	16,853
Deaths	3,015	2,366	1,279	251	54	60	395	634	563	1,047	1,232	2,513	13,291

The case mortality was 78·8 per cent.

The Sanitary Commissioner for the Madras Presidency in his Annual Report for 1903 states his opinion that "undoubtedly much of the plague infection of this Presidency has been derived from Mysore" where less stringent measures are employed for repressing the disease.

The City of Madras, population 493,680, continued to enjoy comparative immunity from plague, only 6 deaths from that disease being recorded during 1903.

Bengal Presidency.

Plague showed a marked increase during 1903 in the Presidency of Bengal, the number of reported cases being 74,265, of which 65,680 proved fatal. In the previous year there were 37,529 attacks and 33,256 deaths. Among the districts which suffered most were Saran (25,571 fatal cases), Patna (4,638), Shahabad (7,596), and Calcutta (8,222). The progress of the plague prevalence followed the usual course, reaching its highest point in March, thereafter declining rapidly and recrudescing again in September, as may be seen in the subjoined table :—

Plague in the Bengal Presidency.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Deaths.. ..	2,763	12,806	20,975	11,963	1,272	182	114	105	281	612	2,233	5,353	65,680

The case mortality was equal to a rate of 88·6 per cent. Evacuation of the inmates and disinfection of the invaded houses were the chief means employed to prevent the spread of the

disease, but even these measures were only partially applied. Disinfection of clothing was found difficult to carry out, since infected clothing was taken away by the people when evacuating the invaded houses. Little reliance was placed by the natives upon inoculation, and their faith in it was further shaken by the unfortunate accident which occurred at Malkowali in the Punjab. For this reason comparatively few preventive inoculations by Haffkine's method were carried out during the year.*

Calcutta. Census 1901, population 847,796.—In 1903 plague was again epidemic in the City of Calcutta, the height of the outbreak being reached in March. The total number of cases and deaths recorded during the year was respectively 8,891 and 8,223, as compared with 7,789 attacks and 7,284 deaths in 1902. The subjoined table gives the reported plague cases and deaths as well as the total number of deaths from all causes month by month for 1903.

Calcutta. 1903.	Plague.		Total Deaths from All Causes.†
	Cases.	Deaths.	
January ...	257	245	2,474
February ...	1,197	1,058	2,932
March	3,954	3,526	5,352
April	2,711	2,597	4,315
May	305	320	1,890
June	60	74	1,350
July	54	52	1,387
August ...	55	55	1,352
September ..	76	76	1,474
October ...	72	71	1,614
November ...	82	81	1,938
December ...	68	68	2,061
Total ...	8,891	8,223	28,139

* Thirty-sixth Annual Report of the Sanitary Commissioner for Bengal, year 1903, by Major F. C. Clarkson, Sanitary Commissioner for Bengal.

† This column is compiled from the daily returns. The figures do not agree with those given in the monthly narrative, which latter the Chairman of the Calcutta Municipality states is correct. The discrepancy is stated by the Chairman to be due to the fact that the monthly return includes figures from parts of the City from which daily returns are not received.

The case mortality, which was 92·4 per cent. in 1903, has been relatively high during the six years in which plague has been appearing in Calcutta, and considerably higher than the rate for the whole of India, or for the sister Presidency of Bombay. The number of recognised plague cases and deaths recorded in each year since 1898, together with the case mortality, is given in the table below.

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Calcutta.	1898.	1899.	1900.	1901.	1902.	1903.
Reported plague cases ...	238	3,005	8,822	8,611	7,789	8,891
„ „ deaths...	203	2,745	8,278	7,883	7,284	8,223
Case mortality, per cent.	85·3	91·3	93·8	91·5	93·5	92·4

The United Provincks of Agra and Oudh.

During 1903 plague was epidemic in the United Provinces of Agra and Oudh 84,499 deaths being reported.* This number is in excess of the figures given in the Annual Report of the Sanitary Commissioner with the Government of India, which gives 80,729 deaths as occurring from plague. The discrepancy in the totals is said to be due to some extent to the fact that the larger figures are those supplied by the District Mortuary Registrars, the others being those furnished by the magistrates of the districts.

The epidemic, like that of 1902, reached its height in March and fell to its lowest point in July. The districts principally affected were Cawnpore, Allahabad, and Lucknow. The three towns of the same names also suffered, 5,164 plague deaths occurring in Cawnpore, 4,472 in Allahabad, and 4,325 in Lucknow. In the City of Agra 5,195 persons perished from plague, and in Meerut 4,145.

The subjoined table gives the deaths from plague month by month during 1903 in the United Provinces of Agra and Oudh :—

Plague in the United Provinces.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Deaths.. ..	10,740	13,067	20,671	16,531	3,099	243	36	33	211	1,807	6,795	10,776	84,499

* Annual Report of the Sanitary Commissioner for the United Provinces of Agra and Oudh for the year ending December 31st, 1903.

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The Punjab.

The Annual Report on the Sanitary Administration of the Punjab for 1903 gives the plague attacks as numbering 341,267, and the deaths 210,617; viz., 317,256 cases, and 192,988 deaths in the British districts, and 24,011 cases and 18,629 deaths in the native states.

An official report on "Plague inoculation in the Punjab from October 1st, 1902, to September 30th, 1903," published by Major E. Wilkinson, I.M.S., Chief Plague Medical Officer for the Punjab, contains the statement that from October 1st, 1897, to September 30th, 1903, a period of six years, the notified plague cases have numbered 607,901 and the deaths 377,576. But in addition during the above mentioned period, 77,610 cases and 66,769 deaths were reported from the native states associated with the Punjab* making a grand total for the six years ended September 30th, 1903, of 685,511 cases and 444,345 deaths.

During 1903, there was a gradual increase of the incidence of plague during the early months of the year, 16,608 cases being recorded in January, and no fewer than 113,074 attacks in April. From this point the numbers gradually fell till August, when only 111 cases came under notice. From September another increase was observed up to the end of the year (*see* table below).

Major Wilkinson, in the report above referred to, states that in some districts during 1903 in addition to rats, dogs, cats, squirrels and birds were observed to die during the time the human epidemic was at its height; and it was noticed that the crows left the infected villages till the outbreak was over. Destruction of rats was carried out in those districts where the religious scruples of the Hindus permitted of it, by means of placing a mixture of flour and plaster of Paris near rat holes, and in other cases stuffing the rat holes with a mixture of tar and sulphuric acid. This latter method is a troublesome one and requires careful supervision. Various forms of rat traps were also employed.

During 1903 inoculation with Haffkine's prophylactic was performed in the Punjab on 327,357 persons, and the experience of the period above mentioned confirms previous experience of the value of this measure. Lieut.-Col. Bamber says that the liability of the uninoculated to death from plague was two and a half times as great as that of the inoculated. Of the 327,357 persons inoculated 5,045 subsequently contracted plague, and of these 1,263 died, the case mortality being 25·03 per cent. Of the 336,222 persons who contracted plague not having been previously inoculated 209,434 died, yielding a case mortality of 62·29 per cent.

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* These Native States include Patiala, Kapurthala, Nabha, Kalsia, Maler Kotla, Bahawalpur, Jind, Nalagurh, Baghat, Faridkot, and Dujana.

The following table shows the incidence of plague in the Punjab month by month during 1903 :—

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Plague in the Punjab.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Attacks ..	16,608	29,002	67,366	113,074	60,352	13,191	310	111	389	3,542	7,326	8,416	341,287
Deaths ..	9,304	17,586	40,319	70,219	44,459	14,991	216	65	171	2,053	4,894	6,150	210,627

The largest number of cases and deaths were referred to the Gujranwala district, where 67,901 attacks—44,267 fatal—were recorded. The other districts which suffered heavily were—Lahore, 51,765 cases; Jullunder, 42,813 cases; Amritsar, 37,461 cases; and Hoshiapur, 32,210 cases.

Central Provinces.

During 1903 plague prevailed in the Central Provinces causing 40,660 deaths, compared with 188 in 1902. The disease was epidemic in January, 1903, had all but subsided during June and July, but became again epidemic in the second half of the year, reaching its highest point in November.

The following table shows the number of deaths reported month by month during 1903 :—

Plague in the Central Provinces.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Deaths	4,510	8,175	8,809	3,234	328	7	2	672	3,762	5,421	8,754	8,060	51,514

The epidemic existing at the end of 1903 continued with great virulence up to May, 1904, in the Central Provinces.

Rajputana.

In Rajputana 2,442 fatal cases of plague were reported during 1903, the attacks numbering approximately 2,718.

Mysore State.

The plague attacks recorded in the Mysore State during 1903 numbered 29,405, and of these 22,291 proved fatal. The total cases in the previous year were 38,811 and the deaths 28,278.

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From this it will be seen that there was an appreciable diminution in the amount of plague in Mysore in 1903 as compared with 1902.

The subjoined table shows the number of cases and deaths reported month by month during 1903 :—

Plague in Mysore State.	January.	February.	March.	April.	May	June.	July.	August	September.	October.	November.	December.	Total in 1903.
Attacks ..	5,560	2,712	1,211	471	187	415	1,517	2,351	3,024	4,946	3,437	3,574	29,405
Deaths ..	4,156	2,186	1,022	382	132	306	1,107	1,763	2,943	3,662	2,654	2,997	22,291

The city and district of Mysore and the city and district of Bangalore were among the localities suffering heaviest from the disease.

Hyderabad State.

In the Hyderabad State during 1903 the total plague cases reported amounted to 33,908, of which 28,094 proved fatal, as compared with 10,017 attacks and 8,123 deaths in 1902. In no previous year have so many plague cases and deaths been recorded in this State. The incidence of the disease, month by month, is shown in the tabular statement below :—

Plague in the Hyderabad State.	January.	February.	March.	April.	May	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Attacks ..	2,971	5,803	4,135	1,481	959	5	111	1,256	3,866	5,421	3,806	1,904	33,908
Deaths ..	2,433	4,744	3,662	909	683	3	100	1,377	4,158	3,723	3,241	4,056	28,094

The behaviour of plague in the Nizam's dominions, as exemplified by the mortality, is shown below :—

Plague.	1897.	1898.	1899.	1900.	1901.	1902.	1903.
Deaths	5	3,868	6,378	653	149	8,934	28,094

Central India.

During 1903 plague was epidemic in Central India, 33,162 cases being notified and 21,169 deaths certified from this cause. The majority of the cases occurred during the last four months of the year.

ASSAM.

Plague appeared at Dibrugarh on May 16th, 1903, this diagnosis being bacterioscopically confirmed. It is stated that some dying rats had been observed in the foreign grain bazaar at which the early human plague cases occurred. In all 37 cases and 28 deaths were reported between May 16th and July 3rd.

KASHMIR STATE (with Jammu Province).

In this State there occurred during 1903, 1,190 cases and 1,053 deaths from plague. The largest number of attacks being referred to the months of April and May.

OTHER INDIAN PROVINCES AND STATES.

As regards the other Provinces and States of India, there were 74 cases and 45 deaths in Coorg; 51 attacks, 49 of which were fatal, in the North-West Frontier; 31 attacks and 9 deaths in Burma; four cases, three of which proved fatal, in Baluchistan; and 48 fatal cases in Ajmer-Merwara.

PERSIA.

Persistent rumours were current in the spring of 1903 that an epidemic of plague had occurred of a virulent type at Hawizeh, and in a less severe form among the inhabitants of Beni Truf, in the "marshes." Inquiries instituted as to the truth of these rumours established the fact that during the last two or three years cases of plague have been noted in this locality in the spring months, and that in the spring of 1903 there had been a more serious prevalence of plague in the district than in the two or three preceding years. The Turkish authorities had stopped all communications with the Persian frontier near the Tigris to prevent spread of the disease into Turkish territory. At the middle of May the disease was subsiding, but special precautions were taken to prevent Hawizeh wool being carried from the infected districts into other parts of Persia. No details as to amount of plague attacks or deaths at Hawizeh have been made public.

CEYLON.

A single ship-borne case of plague occurred during 1903 in the person of a passenger arriving by the Austrian s.s. *Marie Valerie* from Bombay. This passenger was landed at the Galle hospital for plague, on March 5th. The patient recovered, and was discharged on April 29th. All the usual precautions were taken and the plague contacts were segregated for 10 days.

STRAITS SETTLEMENTS.

Singapore.—On July 6th an English steamer, the *Oheang Oheio*, arrived at the port of Singapore bringing from Southern China

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856 coolie passengers, who were immediately landed at the quarantine station to undergo the usual period of observation. During the voyage several cases regarded as plague had occurred amongst these coolies. While at the quarantine station the disease broke out among the passengers under observation, and from the 6th of July to the 22nd no fewer than 104 cases of plague or suspected plague were recorded.* The disease, however, did not spread from the quarantine station to the town itself, which yielded only 3 fatal plague cases during the whole year.

Selangor.—In November three cases of plague were reported to have occurred at Kuala Lumpur, the principal town in the Federated Malay State of Selangor. But up to the end of 1903 there was not any report of spread of the disease. In the annual report on the Federated Malay States for 1903, presented to the Colonial Office by the High Commissioner, it is, however, briefly stated that a small outbreak of plague occurred in Ulu Selangor, causing 15 deaths, but no details are given as to source of the infection, or other particulars.

SIAM.

According to a report dated August 22nd plague broke out at Puket on the western coast of Siam, north of Penang. The number of cases, so far as is known, was not large. In the neighbourhood of Puket there are tin mines, in which labourers from South China work. It is supposed that plague was brought to Puket by some newly-arrived coolies from an infected district in China. It was stated that Bangkok, the capital of Siam, was in a very insanitary state, and was overrun with rats. It was therefore fully expected that plague would attack Bangkok; but, so far as is known, that city escaped the disease altogether during 1903.

COCHIN-CHINA (FRENCH INDO-CHINA).

Tonkin.—At the beginning of April, 1903, plague reappeared at Hanoi, and continued to manifest itself up to the end of July, during which time 206 deaths from the disease were officially reported. It has been already recorded that in April, 1902, cases of plague occurred in Hanoi, the capital of Tonkin. Probably the disease had never wholly disappeared, but had continued into 1903 in a mild form unobserved. It is surmised that plague infection was brought from Hong Kong by rats concealed in bales of imported goods to Hanoi. From Hanoi the disease was carried into other localities, but the precise number of these cases has not been ascertained.

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* *Vide.* "Veröffentlichungen des Kaiserlichen Gesundheitsamtes," July 22nd and September 14th, 1903; also "Das Oesterreichische Sanitätswesen," August 27th, 1903

THE PHILIPPINES.

APP. A, No. 1. Summary of the Progress and Diffusion of Bubonic Plague in 1903 by Dr. Bruce Low.

Plague again appeared in the Philippines during 1903, having been practically absent from the Archipelago during the previous year, only nine deaths having been recorded from this cause in 1902. So far as can be learned the recorded cases and deaths from plague in 1903 numbered respectively 218 and 179, the majority of them being referred to Manila and a few to Cebu. In Manila a great effort was made to protect the population against plague by means of inoculation with Shiga's prophylactic fluid. The experience of Manila was to the effect that inoculation with this prophylactic repeated again in 10 days sufficed to establish immunity against the disease. Compulsion was resorted to, and a large proportion of the 60,000 Chinese residents in Manila submitted to the process. It became part of the routine treatment of "contacts" after the month of April to take them to the detention station, inoculate them with Shiga's "anti-plague virus," disinfect their clothing, and then release them. These measures along with disinfection of the invaded houses by means of bichloride of mercury, or by burning them down, and the institution of measures for destroying rats, were the main precautions taken at Manila in dealing with the disease.

The distribution of plague in the Philippines month by month throughout 1903 is shown in tabular form below.

Plague in the Philippines.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Attacks	2	14	44	48	35	30	20	12	6	5	3	2	218
Deaths	2	14	34	47	29	27	8	8	4	2	2	2	179

The case mortality was 82·1 per cent. a high fatality rate which suggests that only severe and fatal cases came under observation, patients being concealed as long as possible.

CHINA.

Hong Kong.—In 1903 plague once again became epidemic in Hong Kong. It has already been recorded that in 1902 the disease appeared in smaller amount than in any of the four preceding years, only 576 cases with 560 deaths being recorded. But in 1903 the number of recognised cases rose to 1,415 and the deaths to 1,252, a case mortality of 88·4 per cent. The annual epidemic began in February and reached its height

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between the middle of May and the middle of June. The subjoined table gives the notified cases month by month.

Plague in Hong Kong.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Reported cases ..	4	29	115	272	515	343	85	32	9	5	4	2	1,415

In a report on plague during the first seven months of the year 1903, presented by the Acting Medical Officer of Health for Hong Kong, and published in the Government Gazette of March 25th 1904, it is stated that 433 bodies of plague patients were found during that period in the streets or other places where they had been left by the friends. This apparently was done with the view of avoiding the dreaded visits of the officials and the disinfection of the house and effects that would necessarily follow. The percentage of bodies found in the annual epidemics of plague during the last six years are given in the report above mentioned and are reproduced here.

Hong Kong.	1898.	1899.	1900.	1901.	1902.	1903.
Plague corpses found in the streets per cent. of total plague deaths.	23·1	24·2	29·5	19·7	34·6	31·7

Plague broke out on board H.M.S. *Ocean* while this vessel was at Hong Kong, six cases being reported. It is also stated that two officers of the Derbyshire Regiment stationed at Hong Kong were attacked by the disease.

Rats were also affected by plague and were found dead in and about houses. A reward of five cents. was paid for each rat brought to the authorities, and there is reason to believe that as a consequence rats were imported from the mainland for purpose of sale. In Hong Kong proper during the year, 54,738 rats were destroyed, and of these 3,026 were recorded as infected by plague. In that part of the colony which lies on the mainland, viz., Kowloon, 46,309 rats were destroyed, and of these 716 were regarded as having been infected by plague. Several cats were also found to be plague infected. In the official report above referred to, it is stated that during the height of the epidemic poultry were found dead in the markets more frequently than usual, and it is asserted that bacterioscopic examination showed that they had died of plague.

The measures employed at Hong Kong to combat plague were mainly: (*a*) The disinfection of houses in which cases of plague

were known to have occurred. But in many instances infected houses never came under observation such persons being removed by their friends from place to place, and the dead bodies of fatal cases being abandoned in the streets or other convenient places. (*b*) The closure of blocks of houses in neighbourhoods where plague was rife to enable disinfection to be properly carried out, shelter being offered to persons thus turned out temporarily from their houses. (*c*) The systematic destruction of rats, with measures for the exclusion of these animals from houses. (*d*) Preventive inoculation with Haffkine's prophylactic. But only 352 men were inoculated, five of whom afterwards developed plague of which two died.

Some researches were carried out at Hong Kong by Dr. W. Hunter, the Government Bacteriologist and his assistants, in detection of plague in man and other animals. Of persons apparently in health, a small percentage are stated to have been found whose blood showed presence of plague bacilli; the inference being that chronic plague existed in Hong Kong among persons apparently well. Dr. Hunter affirms also that in some samples of rice exposed for sale in shops, he found plague bacilli. Should these observations be fully confirmed by other competent investigators our present views on the etiology and prevention of plague may have to undergo modification.

The progress of plague in Hong Kong during the last 10 years is shown in tabular form below.

Hong Kong.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	Total in 10 Years.
Recognised deaths from plague.	2,485	36	1,204	19	1,325	1,487	1,086	1,037	560	1,362	11,091

Canton.—Plague was again epidemic in Canton and district during 1903, having reappeared there in May. Though no official figures are available, it is stated by the United States Consul General that the disease seemed to be more virulent in 1903 than at any time in the previous three years*. At one period (June) of the recent epidemic 50 deaths a day were occurring in this town. From Canton the disease spread rapidly to adjoining towns and villages. Among these may be mentioned Pak Sha lying midway between Canton and Fatshan. Also Honam, Shun Tak, Yuen Kong, and Heung Shan, Sham Shui and Kow Chuk. Considerable ravages were inflicted by plague at Kong Moon, Shui Hing, Lok Lo, To Sing, and other small towns and villages along the banks of the West River. Cases of plague also occurred in the boats and junks plying on the river. In one junk between Kow Chuk and Kong Moon eight passengers died of plague.

* United States Public Heath Reports, July 10th 1903.

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At *Phanthai*, 13 miles south-east of Kit Yang in the Province of Kwang Tung, plague was epidemic and caused 100 deaths in March.

Swatow.—As in the previous year, plague appeared at Swatow and district in the first six months; but as no official records are kept, the precise amount of the disease there cannot be stated. In the United States Public Health Reports for June 26th, 1903, however, it is mentioned that 100 plague deaths had occurred in Swatow up to April 30th of that year.

Amoy.—Plague was epidemic at Amoy in May, the estimated number of deaths daily from the disease in that month being stated to be above 50. Plague continued to prevail till September, but on October 10th Amoy was declared free from infection as no case of plague had occurred for three weeks.

Foochow District.—In June, 1903, a number of fatal plague cases were reported to have occurred at Fuhtsing and Hinghŭa, between Foochow and Amoy. In a letter on the subject which appeared in the *Hong Kong Telegraph* of June 20th, 1903, it is contended that owing to their greater cleanliness and willingness to adopt improved methods, the native Christians have, as a class, learned to cope more successfully with plague than is the case with the superstitious masses of native Chinese; and it is claimed that the mortality from plague has been, relatively to their numbers, much less among the native Christians than among the heathen.

In July, 1903, plague was prevalent at Foochow and it is stated that "typhus fever" was epidemic in the vicinity of Chengtŭ. The professed identification of typhus fever in a locality where plague has been declared to be present, must always excite suspicion; the disease may easily be confounded with plague, there being resemblance in the characters of both diseases. In Foochow plague prevailed in the heart of the city and also in a large village on the south side of Nantai, the island on which the foreign settlement is situated. At the height of the epidemic 50 deaths a day occurred from the disease. After raging for about six weeks the outbreak subsided.*

Peitang, six miles north-east of Taku, with a population of about 13,000, was attacked by plague in September, and up to the end of November upwards of 1,500 persons had perished from the disease. Many of the inhabitants fled from the town as soon as the presence of plague was publicly known.

From Peitang plague was carried to *Tientsin* in October, and also to the villages of *Hsinho* and Shŭnliangcheng. A few cases also occurred at Taku, in all probability due to the spread of infection from Peitang.

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* British Consular Report on the trade of Foochow for 1903.

Weihaiwei.—Mention has been made when referring to plague at Hong Kong about a reported outbreak there of plague on board H.M.S. *Ocean.* Later this vessel proceeded from Hong Kong to Weihaiwei and on her arrival there at the end of June, were found on medical inspection three men suffering from suspicious pneumonic symptoms. It was therefore thought advisable to land the crew of the *Ocean* on Observation Island* and to disinfect the vessel. Material from the three patients was taken for a bacterioscopic examination and sent to Dr. Moore, of Shanghai. His report gave a guarded opinion which did not confirm or disprove the diagnosis of plague. But meanwhile another member of the crew developed pneumonia, of which he died in 36 hours. Material for cultural and inoculation experiments were sent at once to Dr. Moore, whose experiments are said to have demonstrated that the case had not been one of pneumonic plague, but ordinary pneumonia.

MANCHURIA.

Newchwang.—Plague appeared in Newchwang in August, 1903, and from that time up to the end of the year, 1,007 recognized cases were reported, 958 of them proving fatal, a case mortality of 95·1 per cent. The European Consuls resident in Newchwang had no doubt that the above figures did not fully represent the actual amount of plague which occurred in this seaport, for many cases were believed to have been concealed by the Chinese. Newchwang at the time was practically under Russian control, and the regulations which were promulgated for dealing with the epidemic were enforced by the Russian officials. These measures included segregation of the plague patients in hospital, disinfection of invaded houses and of patients' effects, and speedy burial of the dead with due sanitary precautions. At first, before regulations were formulated, the bodies of those dead from plague were simply thrown out into the street and left unburied.

Newchwang was officially declared free from plague on February, 1904.

As to the origin of the 1903 outbreak, not much is known. In the previous year Newchwang had been apparently free from plague, though in 1901 and in 1900 there had been epidemics of the disease in the town ; in the latter year upwards of 2,000 deaths from this cause are said to have occurred. It is believed that the plague which began the epidemic in August, 1903, was imported into Newchwang from an infected Chinese port, but the particular port is not known.

Harbin.—In the latter part of the year plague broke out at Harbin, where cholera also was epidemic at the time. The plague infection was probably conveyed to Harbin from Newchwang.

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* Sometimes called Sun Island.

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JAPAN.

Yokohama.—As mentioned in my report on plague for 1902, the disease existed in Yokohama in the latter months of that year. It was thought that the active measures employed by the authorities had extinguished any chance of a recurrence of the outbreak. But in the month of May, 1903, plague reappeared there. The cases did not occur in large groups, but were practically sporadic throughout most of the year. Altogether some 42 cases and 34 deaths came under observation during 1903. This can hardly be described as amounting to an epidemic among a population of about 200,000.

It is believed by some persons that this 1903 outbreak was due, not to recrudescence of previous infection, but to a fresh importation of the disease from India, or perhaps from Hong Kong. Several instances were reported of plague occurring on vessels arriving in the port of Yokohama. For example: On the s.s. *Kagashima Maru*, on May 4th, a case of plague was discovered in one of the crew. This ship trades between Bombay and Yokohama. On May 27th a Chinese cook on board the German s.s. *Arragonia* was notified to be suffering from plague, of which he subsequently died. The ship had come from Hong Kong on the previous day. On June 15th the *Kaga Maru* arrived at the port of Yokohama from Seattle, having called at Hong Kong. One of the crew was found to be suffering from suspected plague; the diagnosis was afterwards confirmed by the authorities, the patient being removed to hospital where he died.

From Yokohama infection was carried to Shizuoka and Kanagawa Ken, but in no instance was there any further extension of the disease.

It is stated that rats suffering from plague were found by the authorities in Yokohama, and that considerable destruction of these rodents was effected by the methods employed for the purpose.

Nagasaki (estimated population 148,886).—In May a single fatal case of plague was reported at Nagasaki, and later on two others were notified. One of the cases was a Japanese from Inassa, and the other two occurred on board the Russian war ship *Otvazny*, which had come from a Chinese port. No infection of rats was observed in the town. Some 20,000 of these rodents were destroyed during April and May.

Tokio.—At the end of December, 1902, and beginning of January, 1903, a limited outbreak of plague occurred in Tokio, some details of which were given in my last report. There were only 14 cases (with eight deaths), one of the cases being referred to January, 1903, the others to December, 1902. In June, 1903, a single fatal case of plague was reported in Tokio, but no extension of the disease supervened, the infection in this sporadic case having been probably imported. At the end of December it is

stated* that plague-infected rats were found in the Akasaka quarter, in the warehouses of "Nippon Ynsen Kaishi," the great navigation company. But up to the time of writing (August, 1904) no further development of plague had been observed in Tokio.

Formosa.—During 1903 the total number of plague cases reported in Formosa was 889, of which 709 proved fatal.† The majority of these cases and deaths were referred to the months of March, April, and May. Of the total 889 cases, 850 were Chinese and 39 Japanese. As in former years great attention was paid to the destruction of rats, and to the examination of these animals with a view to ascertain if any were infected by plague. No fewer than 137,722 rats were examined, and 402 of them were found to have plague bacilli in their bodies. A small fee was paid for every rat delivered up to the authorities.

The amount of plague in Formosa in 1903 compares favourably with the numbers reported in the five previous years, as may be seen in the table below.

Year.	Plague attacks.	Plague deaths.	Case mortality per cent.
1898	1,233	882	71·5
1899	2,637	1,994	75·6
1900	1,079	809	74·9
1901	4,519	3,634	80·4
1902	2,238	1,740	77·7
1903	889	709	79·7

AUSTRALIA.

New South Wales.

Sydney.—From June 30th, 1902, to June 13th, 1903, no human plague cases had come to the notice of the authorities in Sydney. But in the week ended June 20th a single case was notified, and early in July another came under notice. During the rest of the year, however, no more cases were reported.

* On the authority of the Belgian Consul, *vide* the Belgian "Bulletin Sanitaire," January 21st, 1904.

† Figures from another source (United States Public Health Reports, December 25th, 1903) give the total attacks as 915, and the deaths as 750.

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A careful and extensive examination of rats and mice, week by week, had for some time been carried out in Sydney. But from July 11th. 1902, no plague-infected rodents had been discovered till the week ended May 12th, 1903, when a single infected rat was found, followed by other instances during the next few days. Mice, too, were discovered to be infected during the latter part of May. From May 9th to August 24th no fewer than 8,797 rats and 6,218 mice were bacterioscopically examined, and of these 111 rats and 46 mice were found to be infected by plague. Of the infected rats 11 were discovered among 88 rats taken to the laboratory for examination from a German vessel, the *Alterschwan*, which arrived at Sydney at the end of July from Buenos Ayres and Rosario with a cargo of maize. This ship is stated to have been infested by rats, and a number of putrid rat corpses were found on opening the hatches on arrival at Sydney.

From July, 1903, to March, 1904, Sydney remained free from recognised human plague. The last rodent in which the presence of plague was noted after examination was discovered on August 15th, 1903, and no further plague-stricken rodents were met with till early in March, 1904.

Western Australia.

Fremantle.—Towards the end of January, 1903, a waiter who had applied as an out-patient at the hospital for medical advice was found to be suffering from plague, and during the same week other two persons who had been in contact with him developed the disease. During February, five other persons were attacked, making a total of eight cases, four of whom died. As soon as the first of this group of cases was recognised to have plague careful investigations were begun to ascertain if the local rats had become infected. But no plague-smitten rats were discovered till nine days after the occurrence of the first human case. After this, a number of infected rats came under observation. Up to March 21st, out of 488 rats examined, 89 were found infected by plague. So far as the evidence goes there is a suggestion that the rats got their plague from a human source, and not man from the rat. On April 20th, Fremantle was officially declared free from plague. But almost as soon as this declaration had been made and the isolation hospital closed, a fresh case of plague was imported. The patient was taken ill on board the s.s. *Sultan* which arrived at Fremantle from Singapore on April 30th. Previous to the occurrence of this case there had been no notified plague for 32 days.

On May 25th, another plague case was recognised at Fremantle in the person of a woman who lived next door to a disused flour mill, opposite which a case of plague had occurred 12 months previously. No definite infection of rats could be found.

Yet another case of plague was reported at Fremantle on November 4th in the person of a Chinaman who succumbed to the disease. Altogether 11 recognised cases of human plague came under observation in Fremantle during 1903.

Perth.—In the autumn of 1903 two fatal cases of plague occurred at Perth, but in neither case was the nature of the illness discovered till after death. In both instances the patient was Chinese. A third case was notified at Bellevue, 15 miles from Perth, and proved fatal on November 8th. It is stated that three plague-infected rats were found at Perth about this time. Beyond the above-mentioned cases there was no further manifestation of plague in Perth during 1903.

QUEENSLAND.

Brisbane.—There was a small outbreak of plague in Brisbane in 1903 lasting from February to June, and comprising only 19 recognised cases with 9 deaths. From June till September no plague or suspected plague cases came under observation; but during the latter month two fatal cases were reported, and a third, also fatal, in October, making a total of 22 cases and 12 deaths from plague during 1903. This was the fourth outbreak of plague in Brisbane. For the six months previous to this outbreak, which, as has been said, began in February, a careful examination of rats and mice had been carried out without discovering any infected by plague till February 3rd, when one rat was found to have plague; two more were discovered on February 5th, and another on February 11th, on which day a plague-infected mouse was also discovered. A considerable staff of men were employed during March in laying down poison for rats, setting traps, digging out rat burrows, and disinfecting the soil beneath floors where rats had been found. During the three months—March, April, and May—3,274 rats were received for bacteriological examination, but only 25 rats and three mice were found infected by plague. By June the infection of rats had seemingly ceased; at least no infected rats were found, and Brisbane was then declared to be free from plague. In October, however, plague-infected rats were again discovered.

Townsville.—No indigenous plague cases were reported in Townsville during 1903, the last case having occurred in December, 1902. But in February, 1903, plague-infected rats came under observation.

In September, a plague case was landed at Townsville from a coasting vessel the *Innamincka*, from Melbourne and Sydney. The patient was conveyed to the hospital where he died. There was no extension of the disease from this case. It is stated that the diagnosis of plague was bacterioscopically confirmed by the Government bacteriologist.

Rockhampton.—On February 11th, a Chinaman was attacked by fatal plague in Rockhampton, and at the end of the month a second fatal case was notified.

Bundaberg.—Two plague cases occurred at Bundaberg during 1903. One proved fatal on May 20th, and a post-mortem examination was made upon the body of the patient by the Medical Officer of Health, who, as a result, himself contracted the disease, but recovered.

New Zealand.

Auckland—A single case of plague occurred at Auckland in June, 1903, the diagnosis being bacterioscopically confirmed. The person attacked had been employed in a printing office and is stated to have been handling bales of paper brought to Auckland by inter-colonial boats. In this connection it was pointed out by Dr. R. H. Makgill, the Medical Officer of Health for the Auckland district, that the only known plague case at this time in the neighbouring colonies had occurred at Sydney, in a person also employed in a printing office. No plague-infected rats were discovered at Auckland, and no other human cases supervened.

New Caledonia.

In July, 1903, it was reported officially that plague had reappeared in New Caledonia, a number of natives having died from the disease near Panie, in the north of the island. Later, suspected cases were observed in Neponi on the west coast. Cases regarded as true plague also appeared at Bondo. Two other invaded villages, St. Jean-Baptiste and St. Michel, were burnt down with a view of destroying infected houses. In all, some 139 cases, 120 of them fatal, were recorded in New Caledonia during July, August, and September. In October, the French Foreign Office announced that plague had ceased to appear in this Colony. In a report on the outbreak by Drs. Aubert and Jacquin, of the French Colonial Medical Service, published in the "Annales d'Hygiène et de Médecine Coloniales," No. 4, 1904, it is noted that there was no evidence that plague in this instance was spread by rats, the reporters suggesting however that undue mortality among these animals may have existed, and passed unobserved. Fleas and other parasites which were found in large numbers on the bodies of natives, are at the same time referred to as possibly having had a share in diffusing the disease.

Numea, the capital of the Colony, remained free from plague throughout the year.

HAWAIIAN ISLANDS.

Plague reappeared in the Hawaiian Archipelago during 1903 at Honolulu and at Hilo.

Honolulu, the capital of these islands, has a population of about 40,000. Plague caused 18 deaths during 1903; 15 of them during the first half of the year and 7 in the month of January. No cases or deaths were reported in November or December. Difficulty was found in tracing the source of infection in most of the cases.

Hilo, which is classed as the second largest town in the Hawaiian Islands, had only five plague cases during the year, four of them proving fatal,

UNITED STATES.

San Francisco.—Only 17 plague cases, all of them, however, fatal were reported in San Francisco during 1903. These cases were distributed practically over the whole year, viz., 1 in March, 1 in June, 4 in July, 2 in August, 1 in September, 5 in October, and 3 in November. Plague has persisted in San Francisco since 1900, but has never become fatally epidemic there. The following table shows the discovered cases and deaths in each of the four years 1900 to 1903 inclusive :—

Year.	Plague cases.	Plague deaths.	Case mortality per cent.
1900	22	22	100
1901	30	25	83·3
1902	41	41	100
1903	17	17	100
Total in four years ...	110	105	95·4

Practically only fatal cases have come under official notice, and accordingly there is good ground for suspecting that a considerable number of plague attacks have escaped observation altogether.

Active measures against rats were carried out at San Francisco; rat destruction being largely secured by the laying down of poisoned food (phosphorus on toasted cheese) in the sewers and other haunts of these animals. When, as often happens, the rats began to recognise the poisoned food and to avoid it, phosphorus was no longer used in connection with the cheese, arsenic being substituted for it. Week by week a considerable number of rats were examined bacteriologically. During the first eight months of the year, *i.e.*, from December 8th, 1902, to the beginning of August practically no plague rats were discovered; and from the middle of July to the end of December though upwards of 1,200 rats were bacteriologically examined, only about a dozen were found to be plague infected.

In April, 1903, the United States Government issued a series of Regulations in respect to Quarantine and the prevention of certain diseases, including plague.

The following are the regulations on account of plague specially applicable to shipping :—

(1) For the purpose of these regulations seven days shall be considered as the period of incubation of plague.

(2) In those actually exposed to the infection of plague the administration of anti-pest serum is regarded as a valuable prophylactic measure; for the prevention of the introduction of plague into a community, liable to the introduction through commercial intercourse, immunisation by Haffkine's prophylactic is to be recommended.

(3) Vessels infected with plague, or suspected of such infection, should be anchored at a sufficient distance from the shore or other vessels, to prevent the escape of rats by swimming.

(4) In inspecting vessels from plague-infected ports, or vessels with plague on board at port of departure, *en route* or on arrival, the personnel of the vessel should be examined with special reference to the glandular regions—cervical, axillary, and inguinal—and for such examination as much clothing should be removed as may interfere with the thoroughness of the process. When possible females should be examined by female inspectors.*

(5) In the inspection of vessels for plague special attention must be directed to the discovery of cases of a mild type, or of the pneumonic form of the disease. Suspected or doubtful cases should be subjected to bacteriological examination before the vessel is released.

(6) On all plague-infected vessels, any of the personnel of such vessels who, in the opinion of the quarantine officer, are infected or have been exposed to infection, shall be bathed and body clothing and hand luggage disinfected.

(7) Nothing shall be thrown overboard from the vessel, not even the deck sweepings. Such material shall be burned in the furnaces of a steamer, or in a place specially designated, but not in the galley.

(8) Special precautions must be taken against rats, mice, ants, flies, fleas, and other animals on account of the danger of the infection of the disease being spread through their agency.

(9) As soon as practicable, there shall be a preliminary disinfection with SO_2 for the purpose of killing rats and vermin, before further disinfecting processes are applied to the vessel and her cargo. The killing of any escaping rats shall be provided for by a water guard in small boats, and no person with abrasions or open sores should be employed in the handling of the vessel or her cargo.

(10) The vessel shall be submitted to a simultaneous disinfection in all parts with SO_2 to insure the destruction of rats and vermin. The rats shall be subsequently gathered and burned, due precautions being taken not to touch them with the bare hands, and the places where found disinfected with a germicidal solution, and the quarantine officer shall assure himself that the vessel is free of rats and vermin before granting free pratique.

(11) Disinfection of vessels for plague shall be as follows:—*With cargo*: After 12 hours exposure to SO_2, the upper 4 to 6 foot layer of cargo may be removed and placed on lighters exposed to the sun. This process of disinfection by night, and removal of successive layers of cargo by day, to be continued till the hold is empty.

(12) Vessels without cargo shall be disinfected by SO_2, followed by germicidal solutions, in accordance with the general regulations for disinfection.†

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* The examination herein provided being an exceedingly delicate matter, the greatest possible care is to be used by the quarantine officer to avoid any grounds for complaint of indecent exposure, and more particularly with regard to females.

† These specify the authorised disinfectants, and the proper methods of generating and using the same.

CUBA.

About the end of August, 1903, it was reported in the daily papers that "a mysterious disease presenting many symptoms suggestive of plague" had appeared at Daiquiri, not far from Santiago de Cuba. Samples of blood and sputum were, it appears, forwarded to Jefferson College, Philadelphia, and to Columbia College, New York, for bacteriological examination, with the result that the disease in question was pronounced to be, not plague, but "haemoglobinuric malaria," or blackwater fever.

SAN SALVADOR.

Chalatenango.—In September, 1903, five suspected cases of plague, two of them fatal, were reported to have occurred in the district of Chalatenango, near the borders of Honduras. The diagnosis of the medical men attending the cases was disputed by other authority, the contention being that the malady was not plague but "fiebre carbonosa." No further details of this outbreak have been obtainable.

MEXICO.

Mazatlan.—It has already been recorded that plague, alleged to have been introduced from San Francisco, broke out at the seaport town of Mazatlan in December, 1902, fifty-four deaths being assigned to that cause during that month. The disease continued to prevail in the early part of 1903, and up to the middle of March, 351 cases and 296 deaths had been recorded from plague.* It is asserted that in all probability a number of cases were concealed, and that consequently the above figures do not represent the whole incidence of plague in Mazatlan. The disease was not at once recognised as plague. The first intimation which the Government received was a telegram respecting "several cases of a rare illness, characterised by high fever, enlarged glands which go on to suppurate." A Government bacteriologist was at once sent to Mazatlan to investigate the nature of the illness, and his report confirmed the suspicion of plague. Active measures were at once instituted; lazarets, observation, and sanitary stations were established. Steps were taken to obtain supplies of curative and preventive serums. Five cents were offered for each dead rat brought to the Municipal Authority. As has been said, the epidemic did not last long, for by the month of March the disease subsided. But great pecuniary loss was sustained by the trade of the town and port. A number of houses were burnt down to destroy the infection in them. The Governor of the State of Sinaloa (of which Mazatlan is the capital) officially declared that city free from

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* Dr. E. Liceaga in the "Boletin del Consejo Superior de Salubridad," September 30th, 1903.

plague on April 18th. In May a single imported case of plague was reported at Mazatlan, but no other instance of the disease is known to have occurred during the rest of the year.

Ensenada de Todos Santos.—A small outbreak of plague occurred in this town about the same time that Mazatlan was attacked, but the disease never assumed epidemic proportions. From December 31st, 1902, up to the beginning of June, 1903, only 16 cases, 13 of them fatal, were reported.

Other places in the State of Mexico were invaded by plague during 1903, viz., Villa Union, Sequeros, Oso, and Bagio; but in none of them did the disease become epidemic.

An outbreak of "illness of a highly contagious and malignant type" was reported in May, 1903, from Progresso, a seaport town in the State of Yucatan.* This disease appears to have attacked the Chinese and Mexican labourers employed in plantations near the town of Teket, and to have spread by contact. But no official report on the subject has been received.

BRAZIL.

Rio de Janeiro.—During the last four years plague has repeatedly appeared in Rio de Janeiro, and indeed the city has hardly been free from the disease since April, 1900. During 1903 no fewer than 792 cases of plague with 360 deaths were reported, yielding a case mortality of 45·4 per cent. The distribution of the cases and deaths throughout the year is shown in the table below :—

Plague in Rio de Janeiro.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cases	30	11	9	5	12	13	21	84	111	307	210	99	792
Deaths	16	7	6	3	8	5	7	28	50	87	99	52	360

The larger proportion of the cases occurred, it appears, among the poorer classes of the population. The fatality was not large, and this fact raised doubt whether the prevalent disease could be true bubonic plague. But bacteriological investigation confirmed the diagnosis in many cases, rendering it beyond dispute that the prevalent disease has been true plague. Notification of cases is compulsory at Rio de Janeiro, and isolation of the infected is rigidly enforced. "Contacts" are inoculated with "antipest serum." But no person is removed to the plague hospital before the diagnosis of plague is confirmed bacterioscopically. Other measures employed were the destruction of rats, with flushing and disinfection of the sewers.

* United States Public Health Reports, June 19th, 1903.

The table below shows the incidence of plague in Rio de Janeiro during the last four years, 1900 to 1903.

Plague at Rio de Janeiro.	1900.	1901.	1902.	1903.	Total in four Years.
Notified cases	513	384	461	792	2,150
Certified deaths ...	295	199	215	360	1,069
Case mortality per cent.	57·5	51·8	46·6	45·4	49·7

In *Rio Grande do Sul* City, situated in the Brazilian province of that name, sometimes known as São Pedro, a few plague cases were reported in the early part of 1903. But no details of the outbreak have been made public.

Porto Alegre is the capital of the State of Rio Grande do Sul Plague broke out here in the latter part of 1903, but did not assume the proportions of an epidemic. No official report on this outbreak has, so far as is known, been issued, but it is alleged that cases continued to be reported up to April, 1904. One account from a German source* states that 13 cases were officially notified from October to December, 1903, and that up to March, 1904, some 100 persons had fallen victims to the disease.

Campos.—During October some cases of plague are stated to have occurred in Campos in the State of Rio de Janeiro.

Santos.—A single case of plague was admitted to hospital in November, in the person of a dock labourer who had apparently received his infection from Rio de Janeiro. The patient recovered and there was no spread of the disease.

Pernambuco (estimated population about 200,000), otherwise known as Recife, is situated on the coast of Brazil. Plague had broken out in this seaport in March, 1902, the epidemic continuing till August of that year. Subsequently nothing more was heard of plague till September, 1903, when suspected cases of the disease began to be noted. Some of these cases which proved fatal were certified as "Lymphatitis perniciosa." Ten such deaths occurred in the first fortnight in October. Of 26 "suspected" plague cases admitted to the isolation hospital 12 proved fatal. Other three cases died at their homes, making in all 29 suspected cases and 15 deaths from September 6th to December 22nd. In addition some 17 other deaths were definitely certified as plague; so that 32

* Veröffentlichungen des Kaiserlichen Gesundheitsamtes for April 6th, 1904.

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persons died in all probability from plague in Pernambuco between September and December, 1903. But this estimate is probably below the mark, the Government newspapers having, it appears, continued to deny the existence of plague in the city, notwithstanding the deaths duly certified from this disease. As elsewhere in Brazil the local authorities at Pernambuco neglected to make public the real facts of the outbreak.

Maranhao (or Maranham, sometimes called Sao Luiz de Maranhao), the capital of the Maritime Province of that name, is a Brazilian seaport of some importance. Plague appeared here about the end of October, 1903, but although the existence of the disease was officially admitted no details of the outbreak have been made available. The port was stated in March, 1904, to be still infected by plague.

Para (sometimes called Belem).—This seaport lies on the banks of the Rio Para, an arm or estuary of the Amazon. Plague appeared here early in November, 1903, and continued to February,* 1904. But only 29 cases were notified during that period, viz., in November, 2 cases, December 2, January 11, and February 14. Of these 29 cases 15 died. Twenty-one of them were treated with Yersin's serum, and of these seven proved fatal. The remaining eight cases which were not treated in this way all died. Rats at Para were found to be infected by plague, and the authorities made all residents in houses where plague-infected rats were found submit to protective inoculation.

It is believed that plague was introduced into Para from Maranhao which was infected by the disease in October.

ARGENTINA.

Tucuman.—About the beginning of December, 1903, plague was reported to have appeared in the town of Tucuman. At first the cases were classed as "suspected plague;" but later there appears to have been no doubt as to the diagnosis. One account† states that 120 cases were reported up to the end of the year.

Parana.—At the same time that plague was discovered to have broken out in Tucuman, cases of the disease were reported in the town of Parana in the Entre Rios State of Argentina, and situated on the banks of the River Parana. Only five cases, two fatal, were officially notified. They occurred, it is said, among the employees of a flour mill; but little definite information as to this outbreak or that at Tucuman, mentioned above, has been forthcoming.

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* Further cases were reported in March and April, 1904

† *Vide* "Veröffentlichungen des Kaiserlichen Gesundheitsamtes" for February 10th, 1904.

CHILE.

Iquique.—Towards the latter part of May, 1903, the existence of plague in Iquique was officially noted, the outbreak here as elsewhere in South America being alleged to be due to the importation of infection in a cargo of Indian rice. The disease continued to prevail up to the end of September. No official figures are available as to the number of cases and deaths which occurred during this epidemic, but in the *Public Health Reports* of the United States of December 25th, 1903, it is stated that 182 cases with 108 deaths were recorded here from plague from May 15th to September 30th. No fewer than 40 deaths were referred to the month of July and 30 deaths to August.

Valparaiso.—During June, just after the appearance of plague at Iquique, the disease was rumoured to have broken out in Valparaiso. Some difference of opinion existed between the Board of Health at Valparaiso and the Supreme Board of Health at Santiago de Chile; the former by a majority declaring that plague did not exist in the town, while the latter body insisted that it did. In July three suspected cases were investigated bacteriscopically, and the diagnosis of plague was confirmed. Other scattered cases were reported in the latter part of July and in August. By October the disease seemed to have disappeared from Valparaiso. The precise number of cases and deaths has not been ascertained.

Talcahuano (or *Talcujano*), the port of Concepcion, is stated to have been infected by plague at the end of June, 1903, at the same time that Valparaiso was invaded by disease. No details of the outbreak have, however, been obtainable.

Pisagua, another port on the coast of Chile, is reported to have been invaded by plague in July, 1903, but here again no reliable details have been forthcoming.

It is known, however, that in consequence of the reported invasion of several Chilean ports by plague great alarm arose in South America. In consequence the mail service became disorganised, this disorganisation spreading even to towns which had not been invaded by plague. Other South American States adopted stringent quarantine precautions against Chilean ports, causing considerable inconvenience and loss to travellers and traders.

PERU

Callao.—During May, 1903, alarm was excited in Peru by a report that plague had broken out at Callao among the workpeople employed in the Santa Rosa flour mill. So far as can be ascertained this outbreak comprised 10 cases, four of which proved

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Summary of the Progress and Diffusion of Bubonic Plague in 1903; by Dr. Bruce Low.

fatal. The diagnosis in the early cases was bacteriologically confirmed. As Callao and Lima are practically one town,* both were officially declared infected by plague in May. The infection was supposed by some to have been imported from India by a cargo or cargoes of rice; but cargoes of wheat from Australia came also under suspicion. So great was the alarm at first that it was proposed by the Peruvian authorities to burn down the flour mill and its contents (estimated at the total value of £85,000, and owned by a British firm). But strong representations made on behalf of the owners averted this wanton waste of property, and the destruction actually practised was limited to a quantity of flour supposed to be infected. As the outbreak quickly subsided under the measures of isolation and disinfection adopted, the towns of Lima and Callao were declared officially to be free from plague on June 7th.

Pisco is a seaport town lying on the Pacific coast, about 50 miles to the south of Callao. Plague broke out here in May, 1903, about the same time that the disease was recognised at Callao. The first report mentioned that three dock labourers had been attacked, and that it was surmised that the infection had been brought to the port in a cargo of Indian rice. No further particulars as to plague here have been received.

Pescamayo.—This port lies about 250 miles north of Callao. Plague was first reported here in August, 1903, and up to October some 50 cases had been reported.

Mollendo, a port in the province of Arequipa, was invaded by plague in August, 1903, and the disease was prevalent there till October. On the 7th of the latter month the port was officially declared free from plague. No report as to the number of cases and deaths has come to hand, but one account mentions 30 deaths. It appears to be the policy of the Peruvian Government to let as little information as possible come to light regarding the outbreak. The last reported case seems to have occurred at the end of November, five weeks after the port had been officially declared free from plague.

BOLIVIA.

Under date August 13th, 1903, it was stated† that plague was present at La Paz, in the Republic of Bolivia, but no official confirmation of the report has been received.

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* Callao, the port of Lima, is situated six miles from the latter, the two places being connected by rail.

† United States Public Health Reports, September 11th, 1903.

ENGLAND AND WALES.

A.—*Shipborne plague and suspected plague.*

There was a considerable diminution, during 1903, in the number of ships arriving in the ports of England and Wales, having on board plague or suspected plague, or having had such cases during the voyage.

The total number of these suspected ships amounted in 1903 to only 11 yielding 12 cases, but from none of them was a single plague case landed on English soil. In six out of the 12 reported cases the suspected plague patient had been attacked during the voyage from the East, and these persons had been landed at the Lazaret for Suez at Moses Wells. So far as confirmatory reports by competent bacteriologists went, in one instance only (landed at Suez) was a "positive" diagnosis of plague arrived at. Other eight were reported "negative" as regards plague. The remaining three cases examined in an Egyptian port, were reported by the bacteriologist as "doubtful."

Of the 11 technically suspected ships, seven came from Indian ports, three from Australia, and one from Alexandria. The facts as to each ship are given in the subjoined table.

TABLE I.—Giving names of 11 SHIPS which arrived during 1903 in English Ports under SUSPICION of being infected by PLAGUE; particulars as to Ports of arrival and departure and results of Bacterioscopic Examination where such was made.

Number.	Name of Vessel.	Port of Arrival.	Date of Arrival.	Port of Departure.	Number of Suspected Cases.	Result of Bacterioscopic Examination.	Remarks.
			1903.				
1	S.S. *Oroya*	The Thames ..	January 17 ..	Sydney	1	Negative	
2	S.S. *Clan Farquhar* ..	„ ..	March 7 ..	Calcutta	1	„	
3	S.S. *Omrah*	„ ..	April 22 ..	Sydney	1*	„	* This case was landed at Moses Wells, where the officials of the Egyptian Quarantine Board decided that the case was not one of plague.
4	S.S. *Orizaba*	„ ..	„ 28 ..	„	1†	„	† Case landed at Moses Wells; afterwards found not to be plague.
5	S.S. *Wiston Hall* ..	Liverpool ..	May 15 ..	Bombay	1	„	
6	S.S. *Clan Macfarlane*	The Thames ..	June 23 ..	Vizagapatam ..	1‡	„	‡ Case landed at Moses Wells, and found not to be plague.
7	S.S. *Egypt*	„ ..	July 17 ..	Bombay	1§	Positive	§ Case landed at Moses Wells and regarded as true plague.
8	S.S. *Arracan*	„ ..	„ 31 ..	Rangoon	1‖	Doubtful	‖ Case landed at Moses Wells. Believed not to have been plague, but no report received.
9	S.S. *Clan Shaw* ..	„ ..	October 3 ..	Vizagapatam ..	2¶	1 Doubtful; 1 Negative.	¶ (1) Case landed from this ship at Moses Wells diagnosis not confirmed. (2) Case of illness on arrival in Thames; was suffering from pneumonia, but this was proved not to be plague.
10	S.S. *Pyrrhus*	Liverpool ..	„ 15 ..	Singapore ..	1	Negative	
11	S.S. *Sardinia*	The Thames ..	November 27 ..	Alexandria ..	1**	Doubtful	** Case developed on *outward journey*, and was landed at Alexandria; regarded from the first as doubtful. Diagnosis not confirmed bacteriologically.

From the above table it will be seen that nine of these technically suspected ships arrived at the mouth of the Thames (Port of London), and two at Liverpool. In each instance the necessary measures were taken by the respective Port Sanitary Authorities to deal with the vessel in conformity with the requirements of the Board's Order (Plague, Cholera, and Yellow Fever) of November 9th, 1896.

B.—*Suspected Plague on Shore.*

During 1903 two false alarms of plague occurred, one in a provincial town, the other in the Metropolis. In each instance the circumstances giving rise to the suspicions of plague were carefully investigated by one of the Board's Medical Inspectors.

(1.) On the evening of September 24th, a telegram was received from the medical officer of health to a provincial town of over 45,000 inhabitants, stating that a fatal case of suspected plague had occurred in his district, and asking that the case should be investigated by one of the Board's Medical Staff. Dr. Theodore Thomson who was instructed to undertake the inquiry, visited the town, the same night. From Dr. Thomson's report it appears that the deceased, a lad of 16 a plasterer by trade, had not been outside the district for some considerable time prior to his illness, except on one occasion on September 12th, when he went a day trip by rail to Bristol to attend a football match. He began to complain of feeling ill on September 17th, and noticed a swelling in his left groin. A medical man, who was summoned on September 20th, found him prostrate, with pain and tenderness in both illiac regions; temperature 101°·4 F.; tongue furred and white; pupils dilated; pulse dichrotic; but no spots or rash. Next day his temperature had risen to 102°·6, and gurgling was noted in the right illiac fossa. He was then sent to the isolation hospital as a case of enteric fever. On admission his temperature was 103°·2, and he was delirious. On the 22nd September, his morning temperature was 98°·0, but in the evening it had risen to 102°; the respirations were 50, but no pneumonia was made out. A scanty rash was next observed, beginning as small vesicles or bullae, which became pustular. On September 23rd petechial patches were noticed on his chest. A brawny swelling appeared in front and below the left ear, extending to about 3 inches in length. The patient died early on the morning of September 24th, his temperature just before death having risen to 107°. Dr. Thomson on arrival found that the lad's relatives obstinately refused to permit a post-mortem examination. No enlargement of the femoral or axillary glands could be detected, but two submaxillary glands were noted in front of the brawny swelling which by this time had nearly disappeared. Purple ecchymoses of skin on places where rash had appeared were also observed.

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Dr. Thomson excised* the largest of the two submaxillary glands and brought it back with him to London for a bacterioscopic examination by Dr. Klein. Dr. Thomson before returning to London expressed the opinion that on consideration of all the circumstances of the case the diagnosis of plague was not substantiated; that the death was due in all probability to acute septicæmia. In this connection it is worth mentioning that at one time a suspicion had arisen that the case might prove one of hemorrhagic smallpox. Dr. Klein's examination of the gland proved conclusively that the case had not been one of plague. He reported definitely that microscopically, culturally, and experimentally, the disease was not of the nature of plague. There can be no doubt that the fact that this lad having a few days before his illness visited Bristol, a port exposed to the introduction of ship-borne infection, gave strength to the suspicions of plague aroused by the symptoms he exhibited.

(2.) On Christmas day a telegram was received by the Medical Inspector on duty at office, from the Medical Officer of Health for the Port of London, to the effect that two fatal cases of broncho-pneumonia of a very suspicious kind had occurred at the Seamen's Hospital, Albert Docks. This information was supplemented by a letter addressed to one of the Board's Medical Inspectors, Dr. Bulstrode, from one of the medical staff of that hospital, saying that the deaths in question had occurred in Chinamen who had previously been living in sailor's boarding-houses in Limehouse Causeway. Dr. Bulstrode at once made enquiry on behalf of the Board into the circumstances of these suspicious deaths. The two men had landed from two different ships, one man 10 days, the other 14 days before the onset of the fatal illness. In neither case had the ship come from a port known to be infected by plague. The first man died on December 20th, and the second on the 24th. In the latter instance a postmortem examination, which was made, revealed little to support diagnosis of plague. Material from the body, however, was sent to the Board for bacterioscopic investigation, and Dr. Klein ultimately proved that the illness from which the man had died had been influenza and not plague. While Dr. Klein's bacterioscopic examination was being carried out, it was deemed advisable to communicate at once with Mr. Shirley Murphy, the Medical Officer of Health to the London County Council, which has jurisdiction over London Common Lodging Houses, including Seamen's Boarding Houses. Mr. Murphy with one of his assistants, Dr. Young, and four of his lodging-house inspectors, began on Christmas evening a careful inspection of all the seamen's boarding houses and their inmates in Limehouse, where Asiatics and especially Chinese sailors were likely to be lodging; and in view of the possibility that plague-like illness might be discovered at one or another of these boarding-houses, Mr. Murphy summoned to his assistance Dr. Cantlie, who had previously been appointed by the London County Council, to render help in the diagnosis of suspected cases of plague, to

* Three other medical men were present at the examination of the boy's body; but so strong was their belief that the case was one of bubonic plague, that they preferred to leave the excision of the gland to Dr. Thomson.

accompany the party engaged in inspecting the seamen's lodging-houses. This inspection extended from Christmas evening over the whole of Boxing day. Some minor cases of illness among the Chinese occupants of a lodging-house were discovered, but Dr. Cantlie had no difficulty in pronouncing all such cases to in no way resemble plague, and in this opinion the medical man who had been consulted by the patients, and who had also been summoned to be present at the inspection of the inmates, concurred. As a precautionary measure the London County Council's shelter had been made ready for the reception of "contacts," but fortunately occasion for its use did not arise. The prompt and vigorous action thus taken, under what at first appeared to give grave grounds for suspicion of plague, showed that the arrangements made beforehand by the London County Council under the advice of expert advisers for dealing with plague, were ready to be put in motion at a moment's notice, and further the account I have given illustrates a satisfactory mutual co-operation between the officers of that body and those of the Central Health Authority as soon as occasion for concerted action has seemed to arise.

The subjoined table, inserted for purposes of comparison, gives for England and Wales the number of reported instances of plague and suspected plague, shipborne, and on shore, in each of the five years, 1899 to 1903, inclusive.

Year.	Shipborne plague and suspected plague.		Plague and suspected plague on shore.		Total.	
	Number of instances reported to the Board.	Number of instances in which diagnosis of plague was confirmed by bacteriological examination.	Number of instances reported to the Board.	Number of instances in which diagnosis was confirmed by the Bacteriologist.	Instances reported.	Diagnosis confirmed by the Bacteriologist.
1899 ...	7	—	2	—	9	—
1900 ...	23	4	9	—	32	4
1901 ...	33	4	13	2*	46	6
1902 ...	21	1	1	—	22	1
1903 ..	11	1†	2	—	13	1
Total ..	95	10	27	2	122	12

* Case at Cardiff, and group of cases at Liverpool.
† Case landed at Suez; ship only technically suspected.

FRANCE.

Marseilles.—During June, 1903, the s.s. *Tourray* from Réunion by way of the Cape arrived at Marseilles having on board three cases of sickness suspected to be plague. The vessel was sent to the Frioul Quarantine Station where the usual precautionary measures were taken. But no official details have been received as to whether the cases in question were proved bacteriologically to be plague.

Also in June the s.s. *Senegal*, from Syrian and Egyptian ports arrived at Marseilles, having during the voyage landed a case of plague at Port Said, the diagnosis being bacteriologically confirmed. On arrival at Marseilles the *Senegal* was sent to Frioul where the usual measures were taken; no extension of the disease supervened.

An outbreak of plague, the origin of which has not yet been officially made known, occurred in Marseilles during September, 1903, among the operatives of a cardboard factory in the suburb of St. Barnabe, some distance from the docks. So far as can be learnt from newspaper reports the number of recognised cases was about 15, of which at least 7 proved fatal. But it is believed that some cases of fatal pneumonia which preceded recognition of this plague, were probably instances also of the latter disease.

The source of the outbreak was locally referred to imported rags from Constantinople, Smyrna, or elsewhere; some held the opinion that infected rats had reached the factory in bales of foreign rags. But of this there is no evidence, nor was any proof afforded that local rats had become infected.* Indeed a later report asserts that only Marseilles rags were used at the particular factory. Strangely enough within a few days of the announcement that plague had broken out in connexion with the employees of the factory, this establishment was completely destroyed by fire. It is alleged that the building caught fire during the process of disinfection with sulphur.

As soon as plague was recognised in Marseilles the sick were removed to the Salvator Hospital, and the contacts were segregated till it was deemed safe to liberate them: houses and effects were disinfected; a number of persons were inoculated with Yersin's serum. These and other measures were carried out under the supervision of Dr. Chantemesse of the French Sanitary Service.

Two of the persons employed to attend to the plague patients contracted the disease, viz.:—a nurse and a sister of charity. Some amount of irritation was felt by the inhabitants of the suburb where the plague had shown itself, from the fact that the authorities declined the use of the Frioul Hospital for the town plague cases. The Municipality observed some reticence on the

* In the Lancet of September 19th, 1903, it is stated that "for some time past a great mortality among rats in this factory had been noticed—a fact which should have been a warning of what might be going to happen." But this statement has not been confirmed on definite authority.

subject of the outbreak; it is alleged, indeed, that all the editors of the Marseilles newspapers were summoned by the Prefect and requested by him not to allude to the outbreak in their journals until the authorities had ascertained the names of all persons who were likely to have been in contact with the plague victims.*

Apparently the measures taken were entirely adequate; the outbreak quickly subsided.

The regulations as to fumigation of ships with a view to rat destruction in French ports were carried out in 1903 with what, from the English point of view, seemed unnecessary stringency. On September 23rd an *official* decree was published in the *Journal Officiel* ordering the destruction of rats on board all vessels coming from plague infected countries, or from countries believed to be infected, either during the voyage or *before* the discharge of cargoes in French ports; a special patented process being recommended for the purpose. But the proprietors of this process charged what was considered an exorbitant price for the use of their apparatus, and loud complaints were made thereon at certain ports. Later the stringency of these regulations as to rat destruction were modified.

GERMANY.

Berlin.—A young Austrian medical man who had been sent by the Austrian Government to study the methods employed in the Infectious Diseases Institute under the direction of Professor Koch, fell ill on June 2nd, 1903, with symptoms which suggested pneumonia, and on June 4th was removed to the Municipal Hospital at Charlottenburg, a suburb of Berlin. It soon became known that the patient prior to his illness had been working at the bacteriology of plague, and when his sputum came to be examined the bacilli of plague were found in it. As soon as this discovery was made the patient was removed to the Charité Hospital at Berlin for isolation in one of the detached pavilions set aside for cases of dangerous infectious disease. Here he was treated with injections of Roux-Yersin serum, but he died on June 5th. All persons who had come into contact with this plague patient during his illness were isolated, and each received prophylactic injections of Roux-Yersin serum. With one exception, all remained well. This exception was a male nurse who had waited on the Austrian doctor when he was taken to the Charlottenburg Hospital. This attendant's sputum was found to contain plague bacilli: he however made a good recovery, the Roux-Yersin serum being freely used in his treatment.

From subsequent information it transpired that the young Austrian doctor while injecting a guinea-pig with plague culture, ejected some of the material in the form of spray into the air of the room. Thus infected air was inhaled by him and it is surmised that his infection resulted in this way.

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* Correspondent of the *Libre Parole* quoted in United States Public Health Reports for October 9th, 1903.

All the furniture and effects in the rooms which this Austrian doctor occupied were burnt, and compensation paid to the owners; after which the house was disinfected. As a result of this incident it was decided to impose restrictions upon foreigners who came to the Berlin Infectious Diseases Institute for purposes of study, so that unfortunate accidents of this kind should not occur in future.

Hamburg.—Although no human plague was observed in Hamburg during 1903, rat plague was discovered on board two ships which had arrived in that port from foreign countries.

(1.) The s.s. *Westphalia* in March, 1903, entered the port from La Plata with a cargo of bran, linseed, and wool. On board her on her arrival, plague-infected rats were found. The vessel was at once isolated from other shipping and the holds were fumigated with water-gas generated by a special method devised by Dr. Nocht, the port medical officer, and Herr Giemsa a scientific chemist, the chief active ingredient of the gas being carbonic oxide.* A number of rats were thus destroyed, and there was no extension of the disease either to human subjects or to the shore rats.

(2.) The s.s. *Cordoba* arrived at Hamburg from Rio de Janeiro, Santos, and Bahia on December 24th. After the usual examination the vessel received free pratique and was moored to the dock quay to unload her cargo. On December 28th she commenced to discharge cargo, and on this day seven dead rats were found in one of the holds. The bodies of these animals were at once submitted to a bacteriological examination at the Hygienic Institute with the result that microscopic investigation, as well as the post-mortem appearances, strongly pointed to plague. In consequence the ship was moved from the quay, and the next day the holds were subjected to a thorough fumigation with the "generator" gas mentioned above (the method of Nocht and Giemsa). Dead rats were afterwards collected on board the ship to the number of 139; in various conditions, some in an advanced state of decomposition and others recently dead. The only rats found to be plague-infected were those discovered in the hold first opened from which the seven dead rats were taken on December 28th. All necessary precautions were taken, and no further cases of plague developed among the crew, or among dock labourers who had been engaged in unloading the vessel, nor among the shore rats.†

AUSTRO-HUNGARY.

Trieste.—A report was published in the press of May 29th, 1903, to the effect that the unloading of the cargo of the s.s. *Baron Fairlie*, composed of rice and cotton, had been officially ordered

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* Vide Arbeiten aus dem Kaiserlichen Gesundheitsamt. Band XX. Heft 1. 1903.

† Vide "Die Pest unter den Ratten des Dampfers Cordoba von Hafenarzt Dr. Nocht." Sonderabdruck aus der "Deutschen Medizinischen Wochenschrift," No. 7, 1904.

to be suspended by the authorities at Trieste, and that this vessel, was to be sent to the quarantine station to undergo observation and disinfection. The occasion for this order appeared to be due to the occurrence, on board, of illness in an Indian stoker of a doubtful nature and regarded as possibly plague. The *Baron Fairlie*, owned in England, had come from the Orient, but her precise port of departure was not stated, nor has any further information come to hand as to whether the suspected case proved to be plague. If this case was one of plague it appears to have been effectually dealt with, for nothing further was heard of plague or of suspected plague in Trieste or any other part of Austro-Hungary during 1903.

ITALY.

There were no cases of plague in Italy during 1903 so far as is known. But in two instances ship-borne plague was reported: (1) on board the French steamer *Senegal*, and (2) on board the English steamer *Spithead*.

The *Senegal* arrived at Naples about the middle of June from Port Said; and a case of plague having occurred on board her during the voyage she was sent to undergo the necessary detention and disinfection at the quarantine station at Asinara which is on the Island of Sardinia. There was no extension of the disease in this instance.

The *Spithead* arrived at Genoa in July from Bombay, and commenced to unload her cargo of cotton and linseed. But owing to the illness of one of the crew, a lascar, whom the authorities suspected to be suffering from plague, the work of unloading the vessel was stopped on July 16th and she was ordered to moor in the outer harbour until the case had been investigated bacteriologically. At the same time 80 labourers who had been engaged in discharging her cargo were placed under surveillance. On July 20th bacteriological confirmation of the provisional diagnosis of plague not being forthcoming, the authorities ceased to regard the vessel as plague infected. The *Spithead* then re-entered the harbour and resumed unloading operations.

As regards neither of the vessels above referred to is any mention made, in the reports sent to this country, of the existence of infection, actual or suspected, of rats on board.

It is stated that at Naples, where plague appeared in 1901, strict watch is still kept as to rats infesting the wharves, &c. All dead rats found in such neighbourhood are still submitted to bacterioscopic examination.

GREECE.

Athens.—On September 2nd one of the crew of a steam vessel from an Egyptian port was isolated at the lazaret of St. George's for the reason that he was suffering from symptoms suggestive of

plague. The vessel was placed in strict quarantine, and measures designed to prevent the spread of infection were carried out.* No report confirming or disproving the diagnosis of plague in this instance has been made public, and it therefore remains uncertain whether or not this was a case of true plague.

TURKEY.

Smyrna.—On September 25th, 1903, a case of plague was notified in Smyrna, which proved fatal very quickly. Three cases of suspicious illness resembling plague, one of them fatal, followed in the next few days. In December a fifth suspected fatal plague case was reported. It was surmised that the plague infection had been re-introduced from Egypt into Smyrna.

Rhodes.—Three cases of plague were reported in September on board a sailing ship at Rhodes, three days after her arrival at that place. The vessel left Alexandria on September 4th, and reached Rhodes on September 13th. The first case (the captain) came under medical observation on the 16th, and on the 18th his disease was declared to be plague. The ship was ordered off to the Turkish sanitary station at Chesmeme, but before the vessel could be got away two other members of the crew, which comprised a total of nine all told, developed similar symptoms to those of the captain. This ship had been previously subjected to "*deratization*" at Alexandria.

Kavak.—On December 21st, 1903, the Italian s.s. *Alba* from Catania (Sicily) and Algiers, arrived at the Monastir Aghsi lazaret at Kavak, which lies at the northern end of the Bosphorus, to undergo the preliminary disinfection required by the Turkish regulations before embarking pilgrims for the Hedjaz. Fourteen dead rats were found in the holds of the vessel on her arrival, and, after bacterioscopic examination, it was announced that the bodies of the rats contained plague bacilli. The ship was then fumigated with sulphur, when 12 asphyxiated rats were found: after a second fumigation three more dead rats were picked up. Nevertheless, by order of the Constantinople Quarantine Board (but against the expressed opinions of the British and Italian delegates) the ship was fumigated a third time, after which no dead rats were found.

Later accounts, however, respecting the *Alba* show that a mistake had been made: the bacilli identified by the bacteriologist were not the bacilli of plague. It was shown by the experts who inquired specially into the matter, that the rats found dead on arrival of this ship had suffered from a rat disease similar to that which had been described by Dr. Klein. Thus it was demonstrated that though the bacilli found in the rats were morphologically similar to B. Pestis, these bacilli nevertheless liquefied gelatine: they proved mobile in culture in liquid media,

* Vide Journal de St. Petersbourg, September 3rd, 1903.

and they were not agglutinated by plague serum. It was further shown that at Antwerp three months previously on her arrival from Smyrna, the *Alba* had been thoroughly fumigated in order to get rid of rats, and that after that she had not since visited any port known to be infected by plague.

Djebeil (or Jubeil), a town of 1,500 inhabitants, lies some 15 miles north of Beyrouth in the Lebanon Vilayet on the border of Syria. Plague appeared here about the end of June, 1903, six cases being reported, two of them fatal. One case was bacteriologically investigated and proved to be plague. It is stated that many dead rats were found, about the time, in the shops. It is believed that the infection had been imported by Egyptian smugglers.

Beyrouth.—At the end of June two fatal cases of suspected plague were reported in Beyrouth at an inn, and shortly afterwards the driver of a diligence, plying between Beyrouth and Bekfaya and who frequented this inn, was seized with similar illness. The infection in these cases was probably from the same source as that which caused the attacks in Djebeil.

Assyr.—In July, 1903, it was reported* that plague had again appeared in Assyr, and that the Superior Sanitary Council of Constantinople had declared the coast districts between Lith and Lokeya suspected of being infected by plague. But no details of the outbreak have been received.

Bahrein.—About mid-April, 1903, plague was imported into the Island of Bahrein, situated off the East Arabian Coast, in the Gulf of Persia, and under the Government of the Sultan of Muscat. Bahrein is a noted centre for the pearl fishing. It is said that in April 84 persons died here of plague. The epidemic lasted till the middle of July, and many of the inhabitants fled from the island to the neighbouring mainland of Arabia. One report states that during the three months in which plague prevailed in Bahrein no fewer than 1,000 persons perished from the disease.†

Zobeïr (or Zubeir) lies on the right bank of the Tigris in the Sandjak of Amara in the Vilayet of Bassora, in Mesopotamia, near the Persian frontier. Plague appeared in this locality in April, 1903. There was some dispute as to the nature of the illness, some authorities asserting that it was merely a form of dengue. Turkish military surgeons despatched to the neighbourhood described the disease as characterised by tumours in the groin or axilla, fever, and a general typhoid condition—in some instances marked pulmonary symptoms with bloody sputum—death taking place in fatal cases within a period of 2 to 7 days from the onset. This description of the clinical features of the disease is consistent with a diagnosis of plague. Dr. Clemow, of

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* Das Oesterreichische Sanitatswesen, July 30th 1903.

† Veröffentlichungen des Kaiserlichen Gesundheitsamtes for August 19th, 1903.

the Constantinople Superior Council suggests that this outbreak may have been due to importation, or perhaps to local endemicity of the disease, this portion of Mesopotamia being regarded with some reason as a permanent centre of plague. In Zobeïr itself during April and May 49 cases and 40 deaths were reported. By command of the Vali of Bassora all the native huts in the village were destroyed by fire, as also all infected clothing; the losses caused thereby being compensated for, and new habitations erected on another site. The village was meanwhile surrounded by a *cordon* of soldiers.

'a (or Messaïda) lies in the neighbourhood of Zobeïr, invaded by plague-like illness in April and May. ... measures were applied to Messayda as to Zobeïr, .e burning of the huts and destruction of clothing to May 24th 13 fatal cases had been recorded.

ALGERIA.

a report appeared in a continental medical pub- of plague had occurred during the ilometres from the town of Algiers, s between Algiers and Oran.

A report on these cases] blished in the "Archives de Médecine et de Pharmacie Militaires," February, 1904, page 97, by Surgeon-Major M. F. Benoit, entitled, "Une epidemic de peste à Blida en 1903," states that the outbreak was limited to the inmates of a single house. There was apparently no infection of rats. The source of the plague was not discovered, but it was surmised that a grain ship from Taganrog which had touched at Alexandria might have brought the infection to Algiers, and that the grain had acted as a vehicle in conveying infection from Algiers to Blida.

Later in the year, that is in October, the British steamer *St. Hugo* arrived at the port of Algiers from Port Said, having on board two suspected cases of plague. But whether the cases upon investigation turned out to be true plague is not stated.

EGYPT.

During 1903, there were reported throughout the whole of Egypt 303 cases of plague, 160 of which proved fatal—as compared with 481 cases and 291 deaths in the preceding year. The disease followed much the same course in 1903 as it had done in previous years, the greatest incidence being in the early spring, the malady disappearing in the late autumn.

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* Veröffentlichungen des Kaiserlichen Gesundheitsamtes, for September 9th, 1903

The subjoined table gives the distribution of plague in the invaded towns or districts of Egypt, the number of cases and deaths in each, and the approximate date of the first recognised case :—

Province or Government of Egypt.	Town or District.	Plague.		Date of first Case.*
		Cases.	Deaths.	
Galoubieh	Toukh	49	11	January 18th.
„	Galioub	1	1	May 30th.
Minieh	Nagaga	23	15	March 9th.
„	Minieh	13	4	May 1st.
„	Samallout ...	10	5	May 15th.
„	Beni Mazar ...	3	1	June 11th.
Gharbieh	Tantah	13	7	March 29th.
Guiseh	Embabeh ...	2	1	May 12th.
Port Said	Port Said ...	33	13	April 25th.
Alexandria ...	Alexandria ...	129	83	May 16th.
Damietta	Damietta ...	27	19	June 15th.
Total		303	160	—

* *Vide* "Bulletin Quarantenaire d'Egypt," January 7th, 1904.

The case mortality was 52·8 per cent. Of the 160 deaths certified from plague, 77 died outside the isolation hospitals, while 83 died in hospital. The fact that as many as 77 persons died of plague outside hospitals is a proof of the difficulties in Egypt in securing complete and early knowledge of all plague cases; the non-reported cases not being discovered till they are moribund or actually dead, infection has meanwhile had opportunity of spreading from them in the absence of effective isolation and disinfection.

In an official report on plague for 1903, Sir Horace Pinching, Chief of the Egyptian Sanitary Department, says :—"It is interesting to note that the period in Egypt when most cases of the disease appear corresponds with the period when rats are breeding. Almost invariably in the houses where cases occur, and in those adjoining, dead and dying rats are found. For this reason a general disinfection is made not only in the infected houses, but in all the houses adjoining. After such a thorough disinfection, it is rare that other cases occur."

Alexandria.—129 attacks and 93 deaths from plague were reported during 1903. Though this number in a population of over 330,000 is not a very large incidence, it is larger than has been recorded in any recent year. This may be seen by reference to the subjoined table which gives the number of attacks and deaths, with the case mortality, in Alexandria during the five years 1899 to 1903 inclusive.

Year.	Plague attacks.	Plague deaths.	Case mortality. Per cent.
1899	93	45	48·3
1900	37	25	67·6
1901	53	26	50·0
1902	100	50	50·0
1903	129	83	64·3
Total in five years ...	411	229	55·7

Some 12 ships arrived at Suez from the East, technically infected or suspected as regards plague, *i.e.*, having either actual cases on board, or having had cases during the voyage, or while at the port of departure. In no case did any of these vessels give rise to secondary plague cases after arrival at Suez. In every instance the ship and all persons on board were medically inspected by the officials of the Egyptian Quarantine Board, and where necessary the sick were landed at the Moses Wells sanitary station and the ship disinfected.

Important modifications of the existing regulations regarding ships passing through the Canal from infected ports have been brought about by the decisions of the International Conference which was held at Paris in 1903. These modifications of the Egyptian Quarantine Regulations should, when the Convention is ratified, have effect in reducing some of the inconveniences and restrictions to which in the past commerce and shipping have been subjected, and which are incidentally referred to in this report.

ADEN.

During February and March, 1903, four steamships arrived at Aden with cases of plague or suspected plague on board, viz. :—
(1) The *Soudan*, which, on February 20th, landed a single case;
(2) the *Tyrol*, which landed a suspected case on March 3rd;
(3) the *Nowsherra*, which landed two cases on March 6th; and

(4) the *Syria*, which, on March 12th, landed a single case. All four ships had come from the port of Bombay.

During September, a single imported case of plague was notified at Aden, but there was no further spread of the disease.

SOMALILAND.

Early in September, 1903, a single case of plague was landed at Berbera from the troop transport *Canning*; the person concerned presumably coming with the native troops from India on their way to the seat of war against the Mullah in Somaliland. Apparently there was no extension of the disease on shore or among those who had sailed on board the transport.

ZANZIBAR.

The s.s. *Khalif* of the German East African Line left Durban in March, 1903, for Bombay, and during the voyage seven Indian members of the crew as well as the third officer died from disease regarded as plague, the infection of which was contracted, it is supposed, at Durban, where the disease was present at the time the ship was in port. It is stated* that before plague broke out on the vessel a number of dead rats had been found in the store-room of this ship, and that the third officer had carelessly handled the bodies of these animals with his naked hand. On arrival at Bombay the vessel was duly dealt with and thoroughly disinfected, and after a delay of five days the *Khalif* sailed for Zanzibar, but carried no passengers. On this voyage the first officer and the chief steward died from what the captain considered "malaria." There was no surgeon on board, so that this cause of death was not medically certified. On arrival at Zanzibar on April 7th the ship was sent to the appointed station, where she remained till April 16th. But no further cases of illness supervened, and the ship after disinfection received free pratique. (*See also* under Port of Bombay, page 244.)

MOZAMBIQUE.

Inhambane.—On January 26th, 1903, the Acting Governor-General of Mozambique announced that a case of illness suspected to be plague had occurred in a native passenger on board the coasting s.s. *Matabele*, which had arrived from Durban. It was regarded as highly probable that this person's infection had been received at Durban, where the disease was at the time prevalent. No extension of the infection took place in Mozambique from this imported suspected case of plague.

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* "Veröffentlichungen des Kaiserlichen Gesundheitsamtes" for July 15th, 1903.

MAURITIUS.

During 1903 plague was again epidemic, as in the four previous years, the number of attacks recorded being 1,390 and the deaths 1,035, a case mortality of 74·2 per cent. A comparison of annual epidemics of plague in Mauritius is given below in tabular form.

Year.	Plague.		Case mortality. Per cent.
	Attacks.	Deaths.	
1898	2	2	—
1899	1,416	1,117	78·9
1900	796	593	74·5
1901	1,093	805	73·6
1	506	386	76·3
... ...	1,394	1,034	74·2
Total in six years ...	5,207	3,937	75·6

The epidemic of 1903 began practically in July, and, as in former years, the greatest amount of the disease occurred in the latter part of the year, October and November giving the largest monthly numbers. The distribution of the plague attacks month by month during 1903 is shown in the subjoined table.

Plague at Mauritius.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Attacks	42	13	3	3	5	5	30	80	169	423	319	302	1,394
Deaths	28	4	3	2	4	5	24	63	150	306	237	219	1,034

The continued persistence of plague, particularly in Port Louis, the capital of this island, would appear to be associated, among other things, with concealment of cases. From the monthly official returns extending from August, 1900, to the beginning of January, 1904, comprising a total of 3,663 recognised plague cases, it appears that no fewer than 1,357, or 37 per cent. of the total cases, were only discovered after death. How many non-fatal cases were successfully concealed it is impossible to say. It is evident that with this concealment of cases and the consequent

absence of the necessary isolation of the patients and disinfection of invaded houses and the contaminated effects, extinction of plague was hardly to be looked for. More than half of the persons attacked were of Indian nationality, a race even more prone perhaps than the native Mauritian to conceal the occurrence of disease from the local authorities.

With regard to the distribution of the plague cases and deaths throughout the different districts of the Island, the following table shows that rather more than three-fourths of the total in each instance was referred to Port Louis :--

Districts of Mauritius.	Plague.	
	Attacks.	Deaths.
Port Louis	954	753
Pamplemousses	12	9
Rivière du Rempart	7	6
Flacq	9	4
Grand Port	42	32
Savanne	26	16
Plaines Wilhems	308	196
Black River	3	3
Moka	33	15
Total	1,394	1,034

NATAL.

As mentioned in last year's summary, plague broke out in Durban early in December, 1902. From 4th December, 1902, to 15th August, 1903, 221 plague cases were notified in the Colony, of which 162 proved fatal,* a case mortality of 73 per cent. From August 15th to the end of November Natal was free from plague; but for the fortnight ended December 5th two cases (fatal) were reported from Pietermaritzburg, making a total, for the year 1903, of 223 cases and 163 deaths from plague in this Colony. Of the total cases 203 occurred in Durban, with 147 deaths; 9 cases

* "*Report on the Plague in Natal*, 1902-3," by Ernest Hill, M.R.C.S., R.C.P., D.P.H., Health Officer of the Colony. 1904.

Pp. A. No. 16. Summary of the Progress and Diffusion of Bubonic Plague in 1903: by Dr. Bruce Low.

(7 fatal) were referred to Pietermaritzburg; and the remainder were natives who had become infected at Durban and elsewhere, but whose illness occurred in outside kraals or locations.

In a number of instances the nature of the illness was not discovered till after the sufferer had succumbed, or until it was too late to remove him to hospital. No fewer than 15 persons were found dead presumably of plague, no information as to previous illness having been received by the health authorities. The Health Officer for the Colony expresses the opinion that the plague was in the main spread by the agency of infected rats and mice. It is worth mentioning in this connection that no infected rats were found in Durban from August up to the end of the year; that is to say, the rat epidemic apparently subsided coincidently with the human plague epidemic. The infection in the first instance is believed by him to have been introduced into Natal by the s.s. *Kassala*, a vessel which brought a cargo of forage from Argentina to Durban port in November, 1902. It is surmised that plague infected rats were landed in this forage at Durban, but no proof on this point is forthcoming, and it is admitted that evidence as to any illness or mortality among rats on board the vessel in question is altogether wanting. Three of the Durban cases belonged to the s.s. *Zingara*, which arrived in that port from Madagascar on May 22nd, 1903. One of the persons attacked went on shore the next day, but the other two remained on board. On May 27th the man who had been on shore fell ill with plague, as also did a man who had not been on shore, and on June 1st the third, who had not left the ship, was likewise attacked. No common source of infection was traced, but Dr. Hill suspects fomites or food from shore. Dead rats were found at a brewery in Pietermaritzburg in March, and four out of six cases which were reported between March and May were persons connected it is said with this brewery.

The distribution of the 202 cases and the 147 deaths which occurred in Durban during the epidemic, from the beginning of December, 1902, to the end of December, 1903, is shown month by month below:—

Durban	December, 1902.	1903.												Total in 13 Months.
		January.	February.	March	April	May.	June.	July	August	September.	October	November.	December.	
Plague cases	13	[illegible]	39	30	26	33	5	5	1			2	—	202
Plague deaths .	7	26	27	25	22	28	4	4	1	—	-	1	—	147

It deserves notice that at Durban the Medical Officer of Health for that town, Dr Murison, a rat catcher, two disinfecting coolies, and the mortuary attendant, contracted plague, in the course it is believed of their special duties.

Of 124 cases isolated in the Durban Plague Hospital 61 were treated with Yersin's serum, of whom 33 died, whereas of 63 who had no serum treatment 39 died, a mortality respectively of 54 and 62 per cent. In ten cases the serum injection was withheld as the patients were moribund on admission, a circumstance which makes the mortality of those not treated with the serum appear larger than it really is. In the official report on plague in Natal by Dr. Hill (*see* Part II., page 187) it is suggested that the omission from the calculations of all the white patients, 14 in number, 3 of whom died, will give a fairer test of the serum's efficiency. Thus, taking natives alone, 47 had injections of Yersin's fluid and 30 died, a mortality of 63·82 per cent.; while those treated without serum numbered 63 of whom 39 died, a mortality of 62 per cent.

TRANSVAAL.

In April, 1903, considerable anxiety was aroused in Johannesburg, by the occurrence, under suspicious circumstances, of several deaths of natives, at the same time that some dead rats were found in the market. On the authority, however, of the Government bacteriologist the existence of plague in manor in rats at Johannesburg was officially denied. The deaths of the natives in question were certified after bacterioscopic investigation to have been due to "pneumococcic adenitis."

Later in the year, in July, however, some 13 plague-infected rats were discovered in the Customs warehouse at Johannesburg: which rats were believed to have been brought from distant localities in goods. Measures were at once taken to deal with the rat infection, and there was no extension to the human subject. No human plague cases were identified in Johannesburg or in the Transvaal until the beginning of March, 1904.

CAPE COLONY.

The Cape of Good Hope.—There were no cases of plague in the Cape Peninsula during the early part of 1903, but on March 6th a lascar sailor on board the s.s. *Nevassa*, from Bombay, was attacked by plague and died while the vessel lay in Table Bay. Bacteriological examination confirmed the diagnosis. Investigation was now instituted as to the condition of the rats on board, and though not many rats were met with some of them were found to be plague infected. By March 21st, four other members of the crew of this vessel had been attacked, and 2 of them died from plague. There were 83 passengers on board, but these had landed it is said before the plague case was diagnosed. The ship was sent to Saldanha Bay to be disinfected. There was no extension of the disease beyond the five cases (three fatal) above enumerated, nor was plague discovered among rats in the port till mid-November, when a single plague-infected rat is said to have been found on board the s.s. *Aynar*, from Knysna, which

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was lying at the time in the harbour. This vessel was fumigated by means of the Clayton apparatus; on the conclusion of the process only six dead rats and 13 mice were found on board, none of them affording any evidence of plague infection. With the exception of this one rat not a single instance of plague infection was discovered in the port of Cape Town among the 3,476 rodents which were examined during the months of November and December 1903.

It is considered that the sanitary condition of Cape Town has greatly improved, and that the action of the Cape Government in superseding the inefficient municipal administration during the plague epidemic of 1901 has had a wholesome effect upon the Town Council's attitude towards sanitation and the prevention of disease.

Port Elizabeth.—A recent census gave the population of the Port Elizabeth district as 46,626, an increase of 21,218 since 1891. During 1903, the total plague cases officially notified in Port Elizabeth numbered 135, and of these 75 proved fatal—a case mortality of 55·5 per cent. Practically during each month of the year plague infected rats and mice continued to be found. But notwithstanding that the infection of these rodents continued apparently the same in amount throughout the year the majority of the human plague cases were recorded in the first half of 1903, as will be seen in the table below:—

Port Elizabeth.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Plague cases	2	29	28	33	14	16	4	1	2	4	—	—	135
Plague deaths	2	9	14	22	6	13	4	—	1	4	—	—	75

So that of this total of 135 cases and 75 deaths during the whole year, only 11 cases and nine deaths were reported during the last six months, notwithstanding that plague infected rats were to be found during each month.

There are grounds for believing that the sanitary state of the town of Port Elizabeth leaves much to be desired. It has been affirmed* that certain portions of the place would not disgrace a Chinese town, so great is the overcrowding of persons in dwellings and of aggregation of houses on area. Much dissatisfaction has on this account been aroused locally, and some agitation has been started to secure the whole time services of a duly trained and experienced Medical Officer of Health. It has further been suggested that the reason for the apathy of the municipal authorities is that many of the town councillors are owners of slum property.

* Sanitary Record of April 16th, 1903.

King William's Town.—In the first week of March, 1903, plague broke out in King William's Town, five cases and two deaths being reported in the first fortnight of that month. It was not till the fourth week in March that rats there were found infected by plague. No further human cases were reported for four weeks—*i.e.*, till the week ending April 12th—when three more cases, two fatal, came under observation. Further cases, though in small numbers, continued to be reported during the next eight weeks, till the total had reached 32 cases and 16 deaths. After the beginning of June no more human plague cases were heard of in King William's Town till mid-November, when a single fatal case was reported, making a total of 33 cases and 17 deaths during the year. As has been said, rat plague was discovered four weeks after the first human cases had been reported. After the middle of July no plague-infected rats were found till the weeks ending respectively August 22nd and 29th, in each of which a single plague rat was found. After the end of August to the end of December there were no infected rats reported. The distribution of human plague in King William's Town during the several months of 1903 is given below :—

Plague in King William's Town.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cases	—	—	5	12	10	5	—	—			1	—	33
Deaths	—	—	2	8	4	2	—	—	—	—	1	—	17

The case mortality was 51·5 per cent.

East London.—Plague broke out again in East London in March, 1903, when three cases and two deaths were reported. The total number of notified plague cases in East London during 1903 amounted to 32 and the deaths to 20, a case mortality of 62·5 per cent. There was not at any time an epidemic, but a "dropping fire" of cases continued to occur throughout the year, as may be seen in the subjoined table.

East London.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Plague cases	—	—	3	5	13	3	3	—	1	—	1	3	32
Plague deaths	—	—	2	4	7	2	2	—	1	—	1	1	20

During the first week of March dying rats had been observed at East London in the vicinity of the wharves. During April, May, and June more plague rats continued to be found. Thereafter

[illegible] A. No. [illegible]
Summary of the Progress and Diffusion of Bubonic Plague in 1903 by Dr. Bruce Low.

for an interval of about eight weeks plague-infected rats were not found in the town; but during August rats suffering from the disease were discovered on board the s.s. *Cromartyshire*, from Tacoma, discharging a cargo of wheat and flour into lighters in the harbour. After the cargo had been partly unloaded a number of recently-dead rats were found, and bacteriological examination proved that they had died of plague. The vessel was disinfected by sulphur fumigation and later on by use of liquid disinfectants. Over 100 plague-infected rats were found, but no human case of plague occurred in connection with this vessel. During September plague-infected rats were found in the town, as also during October, November, and December. Whatever may be the relationship between rat plague and the disease in man, it is evident that the epidemic among rats which continued during August, September, October, November, and December had very little effect upon the population of East London; for during that period of five months only five cases—three of them fatal—were reported in the human subject.

Queenstown, which lies some 640 miles east of Cape Town, had hitherto apparently escaped infection by plague, notwithstanding that the disease had been present in one or another portion of Cape Colony since early in 1901. But in July and August, 1903, nine cases of the disease, with eight deaths, were notified, viz., eight cases and seven deaths in July and one fatal case in August. Locally it was believed that plague infection had been introduced by rats, some of these animals suffering from this disease having been found in May at the local railway goods shed. Infected rodents continued to be found during the following months of the year, with the exception of a period of about seven or eight weeks dating from the beginning of September. As in East London so in Queenstown, the continued existence of plague among rats did not apparently have much effect in encouraging plague in man; for although, as has been said above, plague existed among rats practically from May to December, only nine human cases occurred, viz., eight in July and one in August.

Grahamstown.—At the end of March, 1903, a single fatal case of plague was reported in Grahamstown, which is situated about 116 miles from Port Elizabeth, whence the plague-stricken patient had come. Apparently there was no extension of the disease in Grahamstown, and no mention was made of rats there being affected by the disease.

Graaf Reinet, which lies about 200 miles north of Port Elizabeth, suffered from an epidemic of plague among rats from the beginning of February till about the middle of April, 1903. Only one suspected case of plague in the human subject occurred, and this was reported as fatal early in March. No extension of the disease took place, and from April to the end of the year Graaf Reinet appears to have remained free from plague in man or in rats.

Knysna is a small town on the coast west of Plettenberg Bay. In the middle of October, 1903, a single plague case was reported, and about the same time it was observed that rats were dying in the locality. Bacteriological examination confirmed the diagnosis of plague both in the human case and in the rats. No further human cases occurred, though the epidemic among rats continued throughout October, November, and December. It is also mentioned that two cats were discovered at Knysna suffering from undoubted plague.

In a number of other localities in Cape Colony rats were found at one time or another during 1903 infected by plague, but no human cases of the disease were detected. Among such places were *Burghersdorp*, where rats and mice were noticed to be suffering from plague from the beginning of April to the end of June; at *Lady Grey Bridge*, where in November and December rats were attacked by plague. A single plague-infected rat was found in the *Cathcart* district in the police camp a mile and a half from Thomas's River Station. In the *Stockenstroem* district at Seymour Police Camp some plague-infected rats were discovered. At *Riversdale* a sick cat was found to be suffering from plague.

The Annual Report for 1903, of Dr. Gregory, the Medical Officer of Health for Cape Colony, mentions that in the Bacteriological Laboratory under his department 7,907 rats were examined, and that of these 256 were found infected by plague. Similarly, that of 156 mice, 18 were found infected. In addition, 21 cats were examined, and of these 4 were discovered to be infected by plague.

Dr. Gregory also gives a tabular statement as to the amount of plague which has been recorded in each locality invaded by the disease, between February 1st, 1901, and March 31st, 1904. From his report I have extracted the following figures.

Table showing the number of cases and deaths from plague in man, and the case mortality, at each place invaded by the disease in Cape Colony from February 1st, 1901, up to March 31st, 1904. The population of Cape Colony (census of 1904) is 2,405,552 :—

Localities.	Plague.		Case mortality per cent.
	Attacks.	Deaths.	
Izeli...	13	4	30·77
Cape Peninsula	764	371	48·56
Mafeking	2	—	—
Imvani	1	1	—
Carried forward	780	376	—

TABLE—*continued.*

Localities.	Plague.		Case mortality per cent.
	Attacks.	Deaths.	
Brought forward	780	376	—
Port Elizabeth	292	162	55·48
Uitenhage	8	3	—
Mossel Bay and Ladismith	15	6	40·00
East London	34	21	61·76
King Williamstown and Kei Road ...	33	16	48·48
Queenstown	9	8	88·89
Grahamstown	1	1	—
Knysna	1	—	—
On board vessels	10	3	30·00
Total	1,180	596	50·51

Of the total plague cases and deaths, those which occurred among Europeans numbered respectively 297 and 96; among "coloured" 462 and 252; among "natives" 363 and 204; among Chinese 12 and 8; and among other Asiatics 46 and 36.

Among Europeans the case mortality was not more than 33 per cent., whereas among Asiatics it was as high as 76 per cent

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No. 17.

The MANIFESTATIONS of CHOLERA throughout the WORLD during 1903; by DR. R. BRUCE LOW.

INDIA.

In India in 1903 a larger number of cholera deaths were reported than 1901 and 1902 as will be seen in the tabular statement below. The returns for 1903 are as yet incomplete, the reports from some of the smaller provinces and states not having been received up to the time of writing. But from the returns already received the total cholera deaths in India numbered 314,311 as compared with 224,135 in 1902, and 282,634 in 1901. No less than two-thirds of the total deaths from cholera in India during the year under consideration were referred to the Bengal Presidency, where no fewer than 203,405 deaths were recorded, the United Provinces of Agra and Oudh coming next in order with 47,159 fatal cases.

TABLE showing DEATHS from CHOLERA in the various Provinces and States of INDIA, year by year from 1896 to 1903 inclusive.

Population of India (Census of 1901), 294,361,056.

Presidency, Province, or State.	Population Census of 1901.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903
Bengal ..	78,493,410	226,824	196,247	65,020	107,878	345,878	110,763	150,971	203,405
Bombay ..	25,461,209	35,404	57,109	4,368	8,579	153,859	13,600	3,229	1,835
Madras ..	42,397,523	47,847	143,445	65,444	29,062	60,662	81,370	39,769	27,393
Punjaub ..	24,754,737	5,146	622	33	1,816	28,260	180	371	14,698
United Provinces.	48,493,879	69,147	41,208	2,508	9,142	84,960	53,995	25,180	47,159
Central Provinces.	11,873,029	52,985	57,131	7	76	63,114	49	28	437
Berar	2,754,016	12,264	10,122	—	541	18,575	17	16	—
Central India	8,828,761	15,766	13,202	2	—	20,450	72	—	1,110
Hyderabad State.	11,141,142	525	1,039	6	—	3,831	1	—	98
Mysore State	5,559,590	2,100	4,248	1,193	123	779	11,351	—	—
Coorg ..	180,607	49	106	8	—	—	58	—	—
Lower Burma	5,540,265	2,959	8,538	2,972	4,942	3,440	3,552	1,941	5,346
Upper Burma	3,594,229	†	†	†	2,050	41	1	57	2,887
Rajputana ..	9,723,301	—	—		—	—	—	—	236
Ajmerwara ..	476,919	12	19	1	1	4,843	50	32	—
North West Frontier.	2,125,480	—	—	—	—	—	117	—	1,354
Assam ..	6,130,343	17,142	33,240	11,149	8,380	23,761	7,468	13,868	8,573
Total		488,670	569,276	152,711	171,410	832,282	282,634	234,135	314,311

Bengal Presidency.

There was a considerable increase in the number of cholera deaths in this Presidency during 1903 as compared with the two previous years, the number being 203,405 against 150,971 in 1902 and 110,753 in 1901. The districts which suffered most in the past year were Champaran (13,778 fatal cases), Shahabad (12,027), and Darbhanga 11,372 in the Patna division; 24 Parganas (12,103 deaths) in the Presidency division; and Cuttack (10,589 fatal cases) in the Orissa division.

The following table gives the number of cholera deaths month by month for 1903 in Presidency of Bengal.

Bengal Presidency.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cholera—													
Deaths ..	13,456	9,183	13,618	21,770	23,088	25,367	37,286	25,963	8,642	4,414	7,784	12,884	203,405

In *Calcutta* 1,990 deaths were certified from cholera during the year as compared with 2,716 in 1902, and 1,720 in 1901. The distribution of the cholera deaths in this city throughout the months of 1903 are shown in the subjoined table:—

Calcutta.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cholera—													
Deaths ..	172	207	274	488	269	149	90	30	24	40	119	119	1,990

Calcutta has a filtered water supply which is examined bacterioscopically every week. During 1903 no cholera vibrios were found in it. The Medical Officer of Health, Dr. Nield Cook, in his annual report expresses the opinion that the continued appearance of cholera in Calcutta is due in a large measure to importation of the disease by pilgrims from outside the town. The water in a nullah connected with a native temple in the town was found very impure, and it contained cholera organisms. The devotees bathe in this water, and also drink it, and by this means contract cholera.

Bombay Presidency.

During 1903 the number of cholera deaths registered in the Bombay Presidency was comparatively small, amounting only to 1,825, as against 3,229 in 1902, and 13,600 in 1901. The districts

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which chiefly suffered were Sukkur (652 deaths), Larkhana (912 deaths), and Upper Sind Frontier (130 deaths). The total recorded attacks are stated to have been 2,768, so that the case mortality was 65·93 per cent.: this rate being high suggests that in all probability a number of attacks did not come under observation. Only 17 cholera deaths were certified in the City of Bombay.

The incidence of cholera month by month in the Presidency during 1903 is shown in the table below.

Bombay Presidency.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cholera—													
Deaths ..	2	2	2	—	[illegible]	[illegible]	333	407	[illegible]	[illegible]	13	7	[illegible]

The total deaths certified from dysentery and diarrhœa in the Presidency during 1903 amounted to 55,443.

The deaths from cholera in this Presidency during the last 21 years are shown in the following tabular statement.*

Bombay Presidency.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Cholera—										
Deaths ..	87,964	13,804	87,287	167	26,711	39,606	32,451	5,389	17,889	42,900

—*cont.*

1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.
8,853	33,538	6,990	35,404	5,710	4,366	8,070	133,899	13,808	3,229	[illegible]

MADRAS.

Cholera, though present during 1903 in the Presidency of Madras, was less prevalent than in former years, there being fewer deaths from the disease than in any of the previous seven years as may be seen by reference to the table below.

Madras Presidency.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.
Cholera—								
Deaths	47,847	143,445	66,444	29,062	60,863	81,370	29,709	27,303

* Abstracted from the Fortieth Annual Report of the Sanitary Commissioner for the Government of Bombay, 1903, with Appendices.

This welcome diminution of the annual loss of life from cholera has, unfortunately, not been apparent in certain of the other provinces of India, where an increase instead of a diminution has been recorded.

The following tabular statement shows month by month the number of certified deaths from cholera in the Presidency during 1903.

Madras Presidency.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October	November.	December.	Total in 1903.
Cholera—													
Deaths ..	1,573	1,281	1,108	1,078	1,556	3,491	3,970	2,314	1,206	1,133	1,480	7,203	27,393

The chief districts of the Presidency affected by cholera during 1903 were Malabar, with 6,157 deaths; Madura with 4,422; Salem with 4,048; Tanjore with 3,878; Trichinopoly with 2,938; and South Arcot with 2,098.

In addition to the 27,393 cholera deaths, there were certified in the Madras Presidency 49,389 deaths from diarrhœa and dysentery. Of these, 7,835 were referred to Malabar district, the highest number in any of the 22 districts comprised in this Presidency.

United Provinces of Agra and Oudh.

The deaths caused by cholera in these United Provinces during 1903 amounted to 47,159, against 25,160 reported in 1902. In each month of the year deaths from cholera were recorded but the height of the prevalence was reached in July when 16,899 fatal cases were certified. In the table below the mortality from cholera in the United Provinces in 1903 is shown month by month.

United Provinces.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cholera—													
Deaths ..	55	130	168	1,028	3,769	8,461	16,899	6,536	3,985	3,466	2,048	614	47,159

The districts which suffered in the greatest proportion were Garhwal, Ballia, Ghazipur, and Rae Bareli.

Punjaub.

There had been very little cholera in the Punjaub during the two years antecedent to 1903, 371 deaths only in 1901 and 180 in 1902 having been reported. About the middle of April, 1903, the

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disease broke out at the great fair held at Hardwar and was carried from that place by pilgrims to other districts in the Province. Altogether 14,688 deaths from cholera were reported. The epidemic reached its height in July, and the districts which suffered chiefly were Ferozpore, Lahore, Ludhiana, and Umballa.

The disinfection of wells by the permanganate of potassium process was carried out in places invaded by the disease.

The following Table shows the incidence of fatal cholera month by month in the Punjaub during 1903.

Punjaub.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cholera—													
Deaths ..	—	—	—	239	950	3,654	6,184	2,309	1,512	431	17	2	14,688

Rajputana.

There were only 236 cholera deaths in Rajputana during 1903.

Central Provinces.

There was relatively very little cholera reported in the Central Provinces during 1903, the total certified deaths from this cause numbering only 437.

The following tabular statement shows the distribution of fatal cholera cases throughout 1903 in the Central Provinces.

Central Provinces.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cholera—													
Deaths ..	—	—	—	17	12	77	84	6	69	158	17	—	437

North West Frontier.

In this province 1,354 cholera deaths were reported in 1903. The districts which suffered were Peshawar, Kohat, Bannu and Hazara.

Burma.

Lower Burma.—During 1903 the reported attacks from cholera in this province amounted to 8,532; and the deaths were 5,346 as compared with 1,844 fatal cases in the previous year. The district which suffered most was Akyab, and after this came

Amherst and Thongwa. The towns most affected were Moulmein, Nyaunglebin, and Ma-ubin. At Rangoon some 120 cholera deaths were reported.

The case mortality was equal to a rate of 63 per cent. The largest number of cases occurred in April and May and the fewest in September, October, and December.

Upper Burma.—The number of fatal cholera cases recorded in Upper Burma during 1903 was 2,887, the districts suffering most being Pakokku and Minbu. At Mandalay 79 cholera deaths were certified. The early months of the year were practically free from the disease, only one death being reported during the first quarter. The epidemic was at its height in July and August.

Mysore State.

Only 98 cholera deaths were reported during 1903 in the State of Mysore.

Central India.

The total cholera deaths recorded in Central India during 1903 amounted to 1,110.

Assam.

The cholera deaths in Assam during 1903 numbered 8,373 compared with 12,664 during 1902. Fatal cases occurred in every month of the year, but the highest mortality from the disease was observed during May, June, and July. The chief districts which suffered were Sylhet in the Surma valley, and Nowgong (principally among the villages along the banks of the Kalang River), Darrang, and Kamrup in the Brahmaputra valley.

The distribution of the cholera deaths throughout the year in Assam is shown below :—

Assam.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for 1903.
Cholera—													
Deaths ..	743	209	188	884	1,333	1,401	984	560	517	399	649	506	8,373

In addition to the 8,373 cholera deaths, there were registered in Assam during 1903, 10,516 deaths from dysentery and diarrhœa, nearly 4,000 of which were referred to the Sylhet district mentioned above.

French Indies.

In the French Indies there were reported, during 1903, 435 cases and 253 deaths from cholera, the Establishment of Chandernagor furnishing the largest number of attacks.

AFGHANISTAN.

In October 1903, a report appeared in a Russian newspaper that cholera had broken out in Afghanistan. Later reports showed that the disease was epidemic in Cabul and at Kandahar; about the end of the year it invaded Herat. In consequence of the outbreak in his capital the Ameer of Afghanistan left the city till the disease had subsided. No definite particulars of the number of cases and deaths from cholera in the above-mentioned cities have been obtained.

CEYLON.

An instance of ship borne cholera occurred at *Colombo* on March 1903. The patient was landed from the ss. *Clan Stuart* had left Calcutta on February 24th. On February 26th, ...ys after leaving that port, a stoker was attacked by illness choleraic kind and died next day, the cause of death not been definitely made out by the master (the ship carried no ...geon). On March 2nd another stoker, who had waited upon the vious patient, was attacked by cholera, and this was the case ich was landed at Colombo. The ship was medically inspected ... then disinfected before sailing for Suez, where a second ection and medical inspection was carried out before the . was accorded pratique. The *Clan Stuart*, it may be added, ... at the mouth of the Thames on March 29th when all persons on board were found to be well, no other cases of suspicious illness having occurred since the ship sailed from Colombo.

During the year the total cholera cases and deaths coming under official observation in Ceylon numbered respectively 46 and 23, as against 179 and116 in 1902. This comparative freedom from cholera during the year is attributed to the closing of the North Road coolie route and to the "quarantining" of coolies at Ragama.*

STRAITS SETTLEMENTS.

From May to November, 1903, the number of cholera cases in Singapore was 226, of which 190 proved fatal, as compared with 842 cases and 759 deaths in 1902.

Two imported cases of cholera were removed from the s.s. *Wakasa Maru* to the port hospital on the arrival at Singapore of that vessel from Hong Kong on November 3rd. Another case, which proved fatal, had occurred during the voyage. While lying in Hong Kong harbour previous to sailing for Singapore a man had been seized with cholera and removed to the hospital, where he died. The *Wakasa Maru* was disinfected at Singapore and fresh drinking water was taken on board before she sailed for Suez.

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* Colonial Report for 1903 : Ceylon.

DUTCH EAST INDIES.

Java.—Cholera is said to have appeared in the city of Batavia (estimated population, 160,000) in October, and it was prevalent till December, causing a number of deaths; but precise details of the outbreak have not yet been received.

SIAM.

Cholera was epidemic in Bankok, the capital of Siam, early in January, 1903, but details of the outbreak are wanting. From the public press* it appears that two masters (both graduates of Oxford) at the King's College died of cholera on the same day about the end of January. Under date February 11th, 1903, the Egyptian Quarantine Bulletin states, that ships arriving at Suez from Bankok had noted on their bills of health the fact that cases of cholera were occurring among the natives in that city.

FRENCH INDO-CHINA.

In March, 1903, cholera broke out in Saigon, the capital of French Cochin China; and the disease spread to the Town of Cholon about eight miles distant, and to other localities. Up to July some 200 cases had been reported, but it is believed that this number does not by any means represent the total amount of the disease. A number of Europeans fell victims to the epidemic. With the advent of the rainy season the outbreak subsided. Cholera also appeared in several districts in Tonkin, but details of these epidemics have not yet been received; it has, however, been estimated that about 2,000 cases occurred.

CHINA.

Hong Kong.—A few cases of cholera were reported in Hong Kong between April and October, 1903; so far as is known there occurred only 11 attacks and 6 deaths. One of the cases was on board a Japanese vessel, the *Wakasa Maru*, mentioned above, from Yokohama while lying in the harbour at Hong Kong on October 30th. The patient was landed at the isolation hospital, where he died. During the voyage of this vessel from Hong Kong to Singapore three additional cases occurred, one of them fatal, on November 3rd. The body of this patient was thrown overboard, and the two remaining cases were landed at Singapore, where the ship was disinfected and fresh water taken on board.

Amoy.—The information obtainable as to cholera in Amoy is small in amount. But it is known that in July the disease had broken out, and that at the beginning of August from 40 to 50 deaths a day were being recorded there from this cause. From an American source† it is stated that 650 cholera deaths occurred there between July 19th and August 1st. Towards the end of August the prevalence of the disease had much diminished, only about 10 cases a day coming under notice.

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* The *Times*, January 26th, 1903.

† United States Public Health Reports September 18th, 1903.

Canton.—Cholera was reported at Canton early in May, but no details of the outbreak have been obtainable.

Shanghai (estimated population in 1903, 575,000). In August, 1903, cholera became epidemic in Shanghai, and up to December 17th deaths had been recorded from that cause. Of the fatal cases 16 were returned as European most of whom were connected with the shipping. The height of the outbreak was reached in September, as will be seen from the table below :—*

Shanghai.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for 1903.
Cholera—													
Deaths	—	—	—	1	1	—	—	27	107	39	1	1	178

In addition to the above deaths from cholera it is suspected that many others were returned as from diarrhœa. During the month of August, as will be seen from the table above, the cholera deaths numbered 27, but those from "diarrhœa" amounted to 142.

Among the instances of cholera on ships from Shanghai may be mentioned the following :—

(1) The s.s. *Poyang* left Shanghai on August 13th for Hankow, all on board being apparently in good health. But during the next four days the captain, the chief mate, the first engineer, and the Chinese pilot died from cholera. Two other officers of the ship were landed at Kinkiang suffering from the disease.

(2) Two cases of cholera were reported at Shanghai in August on board a Russian vessel the s.s. *Otvazny*, on which some five cases occurred later, during the voyage to Japan.

(3) While the s.s. *Braemar* from Yokohama was lying in Shanghai port early in September a stoker died from cholera.

(4) The British barque *Olivebank*, while lying in Shanghai harbour during October, had a small outbreak of cholera among her crew.

From Shanghai cholera was carried on board the s.s. *Shanking* to *Tientsin* at the end of August, and from there to *Peitaiho*. Cholera was also reported at Chefoo in September, probably imported directly or indirectly from Shanghai.

* These figures have been compiled from the Annual Report of the Health Department of the Shanghai Municipal Council for 1903 by Dr. Arthur Stanley, Medical Officer.

MANCHURIA.

In some reports mention was made in the latter part of 1903 that cholera had been prevailing in Newchwang, Inkou, and Kharbin*, but no details of these have been received.

JAPAN.

Nagasaki.—Cholera was prevalent in Nagasaki during the latter months of 1902, and this prevalence continued into the early part of 1903. After this the disease disappeared and no more was heard of cholera until the third week in August of the same year, when a Russian ship, the s.s. *Otvazny* from Shanghai, arrived in the port with two cases of the disease on board and three others of suspicious nature. The sick men were landed at the hospital, where one of them died. A Japanese nurse at the quarantine hospital died shortly afterwards from cholera. In October, cases of cholera began to be reported in Nagasaki, as also cases of a choleraic kind not definitely diagnosed as cholera. From the 13th of October to the 20th of November 169 cholera cases with 92 deaths were recorded. The early cases were bacteriologically examined with a view to establish the diagnosis. Suspicion arose that the cholera outbreak at Nagasaki had been caused by polluted shellfish, and strict regulations were enforced to prevent the use of shellfish likely to have been contaminated. Similarly it was suspected that the earlier cases had been caused by eating "iwashi," a small sardine-like fish, a favourite article of diet, when dried, among the Japanese.

In September, not long before cholera broke out at Nagasaki, cases of what was termed *Cholerine* were reported in the local journals to have occurred in various parts of Japan, among other places in the town of Kobe, in Ehime Ken, and in the island of Shikoku, as also in other places in the south of Japan. In September a suspected cholera case occurred in the person of an American passenger landed from the steamship *Tairen Maru* at Shimoneski. This vessel had come from Chefoo touching at Dalny and at Korean ports.

In October a case of cholera was reported in *Yokohama*, but its origin was not traced and the patient had had no contact with travellers or strangers. No extension of the disease occurred.

In *Tokio* during the hot weather of September, two cases of cholera were officially reported to have occurred in the city; but no spread of the disease supervened.

Formosa.—In October a fatal cholera case occurred at Keelung, Northern Formosa, on board a Chinese junk which had arrived from Amoy.

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* Veröffentlichungen des Kaiserlichen Gesundheitsamtes, November 11th, 1903.

Asiatic Russia.

In *Verkhne-Oudinsk*, a town in the Trans-Baikal Province of [illegible]tern Siberia, two cholera cases occurred early in October, 1903. [illegible] persons attacked had arrived by rail from the "Extreme East." There was fortunately no spread of the disease from these imported cases.*

THE PHILIPPINES.

It [illegible] will be remembered that in 1902 a very severe epidemic of ol[illegible]urred in the Philippine Islands, and that 125,560 cases [illegible] deaths were recorded. This outbreak extended into [illegible]ased considerably less sickness and mortality than in [illegible] year. The reported attacks numbered 40,465, while [illegible] amounted to 28,746.† Cholera cases and deaths [illegible] each month of the year, the highest point of the [illegible]d in August, when no fewer than 10,301 [illegible] were reported. The table below shows [illegible]mic in the Philippine Islands, month by

	[illegible]	[illegible]	[illegible]	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cholera—													
Attacks	4,938	2,899	1,009	1,805	1,632	3,583	4,209	10,301	4,903	2,659	1,150	376	40,465
Deaths	2,761	2,014	1,130	1,174	1,067	2,083	2,844	7,478	3,030	2,087	963	393	28,746

The case mortality rate was 71·0 per cent.

The disease in the earlier part of the year was specially prevalent in the islands of Negros, Panay, Mindanao, Leyte and Luzon; and in the Jolo Archipelago. Later on, an epidemic developed in the island of Cebu. It is admitted officially that in most of the outbreaks the epidemic was traced to specific contamination of water supplies and in a few instances to infected food.

Manila.—During the first three months of 1903 only a few sporadic cases of cholera were met with in Manila; but in May the epidemic became serious, 230 cases with 212 deaths being reported in that month. After this outburst, as will be seen in the table below, the disease lingered on till September when

* Journal de St. Petersbourg, October 27th, 1903.

† Another report in the Veröffentlichungen des Kaiserlichen Gesundheitsamtes for February 17th, 1904, gives the total deaths from cholera during 1903 as 28,891.

another considerable outbreak took place, 290 cases and 263 deaths being referred to that month. This sudden rise in the incidence has been accounted for as follows:—The Pasig River and certain "esteros" were regarded as specifically contaminated by cholera discharges, the previous cholera cases having largely occurred among persons who persisted in using this polluted water for drinking and domestic purposes. About the first week in September a spring of what appeared to be pure water was found discharging into the salt water on the Tondo beach below high tide level, and situated near the point where a sewer had its outfall. The appearance of fresh water rising practically in the midst of salt water deeply impressed many superstitious natives, whose imagination clothed the spring with miraculous properties. In consequence a rumour got about that the water had great curative and restorative powers, and hundreds of persons came to drink the water and carry samples of it home to their friends and relatives. The dangerous circumstances of the spring were recognised by the Health Authorities, but owing to the strong religious feeling which the appearance of the spring had excited in the populace it was not found possible at once to prevent the use of the water. Within the seven days following the discovery of the spring 120 cases of cholera occurred among people, by far the largest proportion of whom had drunk the beach-spring water. Chemical analysis at once showed this water to be highly polluted, obviously from the adjacent sewer.* It is stated that the authorities traced 235 cases of cholera to the use of this infected spring; and that it is well known that many other cases were concealed; indeed, 161 of the discovered cases were not reported till death had supervened.

The appended Table shows the number of attacks and deaths in Manila month by month throughout the year. The estimated population of Manila is 302,154.

Manila.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in 1903.
Cholera—													
Attacks ..	7	2	6	33	290	39	42	89	290	127	31	14	970
Deaths ..	4	1	6	27	212	38	38	72	263	116	26	13	818

The case mortality rate was 89·9 per cent. This high fatality supports the suggestion that cholera cases were habitually concealed by the natives, only the severe cases and those proving fatal, and which could no longer be concealed, coming to light.

* Report of the Philippine Islands Board of Health for September, 1903.

App. A, No. 17.

Cholera throughout the World in 1903, by Dr. R. Bruce Low.

Cholera cases developed on board a number of vessels and small craft while lying in the harbour of Manila, especially on ships and boats lying in the Pasig River, the current of which is sluggish and the waters of which are highly polluted. But in this water the native crews bathe; also they use it for drinking and other purposes.

The public water supply of Manila is taken from the Mariquina River, a tributary of the Pasig. It was known that cholera had occurred in villages situated on the watershed of this river above the intake of the public service, and fears were entertained, especially in June when the river was low, that this supply might become specifically polluted and create an epidemic in the City. Endeavours were made, by the aid of the military, to compel the natives to desist from polluting the water course by excrement; public latrines were established, the fæcal matter from which was carefully dealt with by the authorities.

UNITED STATES.

New York.—The s.s. *Karamania* arrived at New York on March 10th, 1903, and reported that during her voyage from Marseilles, Naples, and Palermo, four steerage passengers and two of the crew had died from a disease regarded as cholera, and that sixteen other passengers had been ill with choleraic symptoms. The Port Medical Officer regarded the outbreak as one of Asiatic cholera; the ship was sent to the quarantine station to be disinfected, and the passengers, 735 in number, as well as the crew were landed on Hoffmann's Island. The first four persons attacked, all members of the crew, began to be ill on February 8th, two days after leaving Marseilles, and of these, two died and one was landed at Palermo for treatment. The symptoms in those who suffered were practically the same—vomiting, cramps, and collapse. There is question whether the illness was not due to some form of food poisoning, no cases of cholera having been known as occurring at Marseilles or Naples before the *Karamania* sailed. It does not appear that there was any bacterioscopic investigation undertaken of these reported cases of Asiatic cholera.

EGYPT.

It has been recorded that a severe epidemic of cholera occurred in Egypt during 1902, no fewer than 40,613 cases and 34,595 deaths being officially reported. By December 31st, 1902, cholera had almost entirely disappeared from the country, the only places technically infected being the city of Alexandria and the district of Sohag in the Province of Guerga. In Alexandria only eight

cases, four fatal, were reported during January, 1903, and in Sohag only one case in the first week of that month. During the rest of the year Egypt remained free from cholera. Two ship-borne cases of cholera or suspected cholera occurred in vessels arriving in Egyptian ports, the particulars of which are given below :—

1. s.s. *Garbieh*.—This ship left Aden on January 13th, 1903, and touched at Hodeida on January 22nd, Massowah on the 25th, Djeddah on the 28th, arriving at Suez on February 4th with 44 passengers and a crew of 36. On medical inspection of the crew and passengers at Suez, one of the latter, who had embarked at Hodeida, showed symptoms of cholera and died the same day, *i.e.*, that of arrival at Suez. Bacterioscopic examination of the case is said to have confirmed a diagnosis of cholera. The ship and those on board were submitted to the usual measures at Moses Wells to prevent spread of infection, and no further cases supervened.

2. The s.s. *Ernest Simons* left Yokohama on March 13th, touching at Shanghai on March 20th, Hong Kong on the 24th, Singapore on the 30th, Bombay on April 9th, Aden on the 14th, and arriving at Suez on the 18th. This mail steamer carried a crew of 201, and 206 passengers. On arrival at Suez, the ship's surgeon reported that a death from choleraic diarrhœa had taken place on April 14th, and that the corpse had been landed at Aden, along with his bedding and effects. The cabin which he had occupied was now disinfected, and the ship was allowed to pass through the Canal in quarantine, after landing seven passengers for Egypt at Moses Wells.

PALESTINE.

There was a slight recrudescence of cholera during 1903 in Palestine, where, in the last quarter of the previous year a sharp outbreak had taken place, the officially reported cholera deaths numbering 3,620. Nothing was heard of the disease during 1903 in Palestine till the beginning of August, when a sharp but short-lived epidemic occurred at *Nabli* in the Mutessariflik of Jerusalem. During the 14 days this epidemic lasted, 102 cases and 57 deaths from the disease were officially reported. About the middle of August, cholera appeared at *Jericho*, but only four cases, all fatal, were officially recognised. Later in the year—towards the end of October—four cases and two deaths were admitted to have occurred in Bethlehem. Another report however, speaks of eleven cases there and eight deaths. The town was surrounded, as usual, by a cordon of soldiers to prevent the spread of the disease. It was believed that cholera was imported from Kerak in Moab, east of the Dead Sea. As no epidemic developed, the military cordon was removed on October 31st. The total officially reported cases in Palestine

during 1903 numbered only 110, and of these 63 proved fatal; but it is probable that the amount of cholera in Palestine during the year was greater than is shown by these figures.

ASIA MINOR.

Vilayet of Adana.—In September, 1903, cholera invaded the eastern portion of this vilayet. The reports as to the number of cases and deaths are somewhat meagre and indefinite. At least two localities, Tschaili and Sayas, are known to have been infected, 12 deaths having been reported in the week ended September 28th. The disease does not seem to have spread from these places, and no extension of cholera westward ensued.

SYRIA AND MESOPOTAMIA.

Cholera, which in 1902 spread from the Hedjas to Egypt, from Egypt northward into Palestine, and from Palestine into Syria, extended in 1903 further northward to the borders of Asia Minor. The disease then turning to the eastward reached certain towns and districts in the valley of the Euphrates, by way of which it travelled southward to the Vilayets of Mossul and Bagdad and in the direction of the Persian Gulf; thus nearly completing a circle from Western Arabia, through Egypt, Palestine, Syria, and Mesopotamia, to the borders of Eastern Arabia.

During 1903 cholera was epidemic in six Vilayets of Syria and Mesopotamia, viz: Syria, Beyrout, Aleppo, Diarbekir, Bagdad, and Mossul. The officially published figures* are 9,201 cases and 6,514 deaths, but these are generally held by Europeans resident in Turkey as not fully representing the facts. It is believed, seemingly on substantial grounds, that cholera appeared in many places from which no returns were made, and that as regards localities from which reports were received many cases and deaths were concealed with or without the knowledge of the local authorities.

The appended map shows the various vilayets and districts in Syria and Mesopotamia invaded by cholera in 1903.

The following table gives the number of cases and deaths from cholera which were reported officially as occurring

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* Taken from "Statistique Sanitaire de l'épidémie de Cholera en 1902 and 1903 (en Syria et Mesopotamia)," issued by the Constantinople Quarantine Board in 1904.

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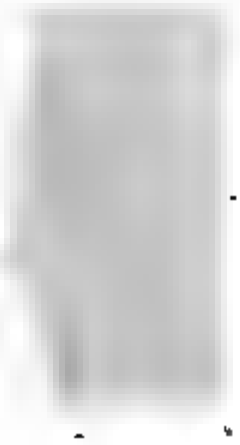
PERSIA
PERSIAN GULF
MEDITERRANEAN SEA
LAKE VAN
Van
Tabriz
Reshit
LAKE URUMIAH
SANDJAK OF MARASH
Marash
ADANA
VILAYET OF DIARBEKIR
Diarbekir
Mardin
Urfah
Harram
Biredjeh
VILAYET OF ALEPPO
Alexandretta
Antioch
ALEPPO
Rakka
MESOPOTAMIA
MUTESSARIFAT OF ZOR
Deir
Mevadin
Hamah
Sebinni
Homs
Erik
VILAYET OF MOSSOUL
Nineveh
Mossoul
Kerkuk
VILAYET OF BEYROUT
TRIPOLI
BEYROUT
VILAYET OF SYRIA
Baalbek
Yahmud
Nebik
DAMASCUS
VILAYET OF
AURE
Caifa
Nasareth
JAFFA
SANDJAK OF HAURAN
Adjem
Belka
Kerak
MUTESSARIFAT OF JERUSALEM
JERUSALEM
PALESTINE
SANDJAK OF MAAN
DESERT OF SYRIA
SANDJAK OF BAGDAD
RIVER EUPHRATES
Anak
Hadissa
BAGDAD
VILAYET OF BAGDAD
RIVER TIGRIS
Babylon
Meshed Ali or Nedjef
SANDJAK OF KERBELLA
SANDJAK OF HILLEH
SANDJAK OF AMARAT
VILAYET OF BASSORA
SANDJAK OF MONTEFIK
SANDJAK OF BASSORA
Bassora
Shaz el Arab



during 1903 in the different Vilayets or Mutessarifliks of Syria and Mesopotamia.

Vilayet or Mutessarifliik.	Reported Cholera Attacks.	Reported Cholera Deaths.
Vilayet of Syria	5,002	3,521
„ Beyrouth	477	366
„ Aleppo	2,234	1,533
„ Diarbekir	65	44
Mutessarifliik of Zor	49	28
Vilayet of Moesul	1 ?	1 ?
„ Bagdad	1,263	958
Total	9,091	6,451

Vilayet of Syria.—In this vilayet there were officially reported 5,002 cases of cholera, and 3,521 deaths, during the year. The distribution of the disease in the sandjaks of the vilayet is shown in tabular form below.

Sandjaks.	Number of Towns or Villages Invaded.	Cases.	Deaths.
Damascus	50	2,935	2,260
Haman	10	1,508	890
Hauran	28	516	333
Ma'an	4	43	38
Total	92	5,002	3,521

In the city of Damascus (population 154,000) 1,339 cases and 1,016 deaths were recorded between March and November. The water supply of the city is largely derived from the River Barada. This water is stated to have been found contaminated by cholera microbes. In reference to the official statistics, one of the European Consuls states that at least 1,360 *deaths* were caused by cholera in the city of Damascus, and as regards the vilayet he asserts

that not far short of 10,000 persons lost their lives during 1903 from the disease.

The source of this cholera has been the subject of much surmise. Some persons blamed the Jewish population; others assumed that the traffic in rags, old clothes, and bedding, had given rise to the outbreak. All known infected houses were surrounded by so-called "sanitary cordons." From Damascus the infection was carried into the adjacent small towns and villages, notwithstanding the military guards.

In the town of Hamah (population 45,000) 606 cases and 348 deaths from cholera were officially reported between June and October, and during the same period in the town of Homs, with a population of about 60,000, there were officially recognised 853 attacks and 515 deaths.

Vilayet of Beyrouth.—In this vilayet eleven localities were invaded by cholera during 1903; but the total number of attacks and deaths was not great, only 477 cases and 366 deaths being officially recorded. These were distributed over four sandjaks, as shown below :—

Sandjaks.	Number of Towns or Villages Invaded.	Cases.	Deaths.
Beyrouth	3	49	26
St. Jean D'Acre	3	14	13
Tripoli de Syria	2	396	317
Lataquieh	3	18	10
Total	11	477	366

The information obtainable as to these outbreaks is scanty. Owing to the critical condition of political affairs in this portion of the Turkish Empire, cholera reports were suppressed. From some places invaded no returns of cholera incidence have been made. It is, however, known than an epidemic of the disease broke out in July in the town of Tripoli (de Syria), population about 30,000, and continued till November. In August, when the disease was attaining epidemic proportions in Tripoli, a panic occurred among the inhabitants, and many of them fled from the town, carrying in some instances cholera infection with them to their place of refuge.

Vilayet of Aleppo.—Three sandjaks in this vilayet are known to have been invaded by cholera during 1903, viz.: Aleppo, Marach, and Ourfa, the total officially reported cases and deaths

having been 2,234 and 1,533, respectively. The distribution of these attacks and deaths throughout the vilayet is shown below :—

Sandjaks.	Number of Towns or Villages Invaded.	Cases.	Deaths.
Aleppo	69	1,691	1,193
Marach	1	5	2
Ourfa	5	538	338
Total	75	2,234	1,533

The places in the Sandjak of Aleppo chiefly affected were the city of Aleppo, one of the principal commercial centres of Turkey with a population of about 127,000, where 429 cases and 400 deaths were reported from September to December; the town of Antioch, with a population of about 23,000, during the same period had 177 cases and 128 deaths; the town of Djisri-Choughour during July and August had 201 cases and 150 deaths; the town of Hazaz during September and October had 111 cases and 58 deaths; the town of Aïntab, with a population of over 43,000, had 120 attacks and 65 deaths.

In the Sandjak of Ourfa, the greatest sufferers were Biredjik, on the Euphrates (population of 10,162), which had 252 reported cases and 123 deaths, and the town of Ourfa or Orfa (population about 55,000) with 218 cases and 180 deaths during November and December. Ourfa is in Mesopotamia, and from this town and district cholera gradually spread to the North and East to Diarbekir, and southwards down the River Euphrates to Kerbela and the Bagdad district.

Vilayet of Diarbekir.—The only locality officially admitted to have been invaded in this vilayet was the town of Diarbekir, which has an estimated population of about 35,000, situated on the River Tigris. During November and December 63 cases and 44 deaths from cholera were officially notified. The persons attacked are said to have resided almost exclusively in the squalid quarter of the city inhabited by Kurds. Refugees from Diarbekir fled to neighbouring districts in panic. At first the Vali of Diarbekir refused to recognise the presence of cholera and instructed the local medical men to keep the occurrence of the disease secret.* There is some evidence that cholera existed in the town in September, that is two months before the presence of the disease was officially admitted. Though not placed upon the returns

* Report of the United States Consul at Harput. *Vide* Public Health Reports, November 20th, 1903.

A, No. 16. issued for the province, it is locally admitted that cholera appeared in the village of Habesh a fortnight after the recognition of the disease in Diarbekir.

Mutessarifik of Zor.—In the village of Meyadine, with a population of about 1,750, cholera appeared in July, giving rise to 49 recognised cases, 28 of which proved fatal. The River Euphrates flows through the centre of this Mutessarifik, the village of Meyadine being situated on its right bank. It is probable that the cholera infection was brought down from Biredjik or other infected locality on the river's course.

Vilayet of Mossul.—The town of Mossul, with a population of over 60,000, is situated on the right bank of the River Tigris to the south of Diarbekir, and some 220 miles north of Bagdad. The appearance of cholera in Mossul was notified during the last few days of December, 1903, the infection having obviously been brought down the river from Diarbekir.

Vilayet of Bagdad.—This vilayet was reported to have been invaded by cholera during October, the large majority of the cases occurring at the town of *Anah*, which has a population of about 3,000, situated on the banks of the Euphrates, less than 300 miles below Biredjik. Cholera is said to have been brought down the river from this place to Anah by a party of travellers on a raft; one of this party had died of cholera on the journey. Up to December 3rd, 526 cases and 281 deaths from the disease were reported. Some cases occurred in the villages adjoining Anah. In the *Bagdad district* during 1903 the total cases officially reported numbered 554 and the deaths 294. In the *Kerbella district*, the principal epidemic occurred in the town of Kerbella, which has a population of about 65,000, and is situated on a branch of the Hindieh Canal to the West of the Euphrates. This city is one of the sacred places of the Mohammedan sect of Shiahs, and holy pilgrimages are made to the shrines. Moreover, it is the place in which every Shiah anticipates being ultimately buried. Kerbella, therefore, contains vast cemeteries or underground vaults in which coffins are placed. The Shiah corpses are brought in considerable numbers from India and Persia, but the law stipulates that the final disposal of the body at Kerbella shall not take place till three years have elapsed since death.

Cholera broke out at Kerbella in December, during which month 674 cases and 634 deaths were officially reported. Cases and deaths occurred also at *Musseyeb* and Hindieh. The reported cholera cases in the Kerbella district amounted to 709 and the deaths to 664, making a total for the Vilayet of Bagdad of 1,263 attacks and 958 deaths from cholera during 1903.

Yemen.

Up to November, 1902, cholera had been prevalent in Yemen and in the adjoining province of Assyr; but at the end of the year his portion of Arabia was declared free from the disease.

No more was heard of cholera in Yemen till early in February, when a female passenger on board the s.s. *Gharbieh*, from the Port of Hodeidah to Suez, died with symptoms clinically identical with cholera. The case was therefore regarded as one of true cholera. No other manifestations of cholera were heard of in Yemen during the rest of the year, though rumours were current during February that some sporadic cases had occurred at Confudah in Assyr.

SOMALILAND.

The *Times of India* of February 28th, 1903, stated that from information given by deserters from the Mullah's army it was believed that cholera was ravaging the rebel tribes in Somaliland. Another report published in the London papers in August spoke of cholera as having broken out in the Mullah's camp. No official confirmation of either of these rumours has been received up to the time of writing.

ENGLAND AND WALES.

There were no cholera cases in England and Wales during 1903; and two ships only technically infected by cholera, *i.e.*, having had cases of the disease on board during the voyage, arrived at the mouth of the Thames during the year. The first of these was the s.s. *Royal*, which arrived on January 30th from Alexandria and Malta, having had on board several cholera cases after leaving the former port. The outbreak comprised nine cases, three fatal; the particulars of these will be found below. On arrival in the Thames all persons on board the vessel were found to be well, and after the usual precautions had been observed the ship was allowed to proceed to the Millwall Dock to unload. The second instance was the Japanese s.s. *Wakasa Maru*, on board which a small outbreak of cholera occurred between Hong Kong and Singapore, four case and two deaths being reported. The ship arrived at the mouth of the Thames on December 16th. On medical inspection all persons on board were found well, and the vessel was allowed to proceed to the Royal Albert Dock to unload (see also p. 303 under China).

MALTA.

The s.s. *Royal* arrived at Malta on January 15th, 1903. She had left Alexandria on January 11th, where she had been lying in port for about 17 days, during which time some members of the crew had suffered from looseness of the bowels. But on the date of departure (January 11th) all the crew were fit for duty and the ship departed with a clean bill of health. Three days later while on the voyage to Malta three men fell ill with diarrhœa, vomiting, cramps, and collapse; one of the sufferers was a stowaway, who died on January 14th. On the same day another member of the crew fell ill and died within 24 hours; he was buried on the island of

P. A., No. 17. Comino, where the Malta quarantine station is situated. A fifth patient was seized with similar illness on January 17th, after arrival of the vessel at Malta, and this man, along with four others suffering from diarrhœa as well as two of the men first attacked, were landed at Comino for isolation and treatment. One of these patients died. Thus, nine cases of choleraic illness with three deaths occurred as a result of this outbreak on board the *Royal* between Alexandria and Malta. It may be added that a few other members of the crew had slight diarrhœa which soon passed off. As there was no surgeon on board none of the earlier cases received medical attention till after arrival at Malta. Before leaving Malta for London on January 19th the forecastle and the cabins occupied by the men were disinfected under the supervision of the Port Medical Officer. The beds and bedding along with the clothing of the sick men were taken on shore and burned. The bilges and water-closets were disinfected, the water tanks emptied and limewashed before being refilled. There can be no doubt that the cholera infection in this instance was received at Alexandria. On the ship's arrival, on January 30th, at the mouth of the Thames all persons on board were found well. After medical inspection, and after the water tanks and bilges had again been dealt with, the ship was allowed to proceed to the Millwall Docks.

APPENDIX B.

No. 1.

MEMORANDUM on RATS and SHIP-BORNE PLAGUE; by DR. THEODORE THOMSON.

In recent years there has been much discussion as to the part played by the rat in the transmission of plague to man; with the result that most writers on this subject now aver that the rat is the chief agency whereby plague is communicated to man. Some, indeed, go so far as to maintain that the rat is the sole cause of infection among human beings in all instances save those in which the disease is of the pneumonic or septicæmic type.

In considering the evidence available on this subject, I propose, in this memorandum, to deal only with that which has concern with ship-borne plague; omitting consideration of the evidence as to the manner of spread of plague from place to place on shore. The latter question, indeed, is of such magnitude and complexity as to render its treatment, within limits of reasonable brevity, extremely difficult; while the former question, although by no means free from like obstacles, is appreciably easier to handle. Consideration, too, of the relationship between ship-borne plague and rats is of more immediate importance in view of the approaching International Conference on Plague and preventive measures in relation therewith; since, at that conference, this particular question is likely to be the main subject of discussion.*

The evidence I have collected on the subject of ship-borne plague in relation with rats has been gathered from the official reports of this and other countries, as well as from medical and public health journals. Notwithstanding the number and diversity of the sources of information to which I have had recourse, I have in many instances failed to procure a complete account of material circumstances. For instance, statement as to whether there was bacteriological confirmation of the diagnosis of plague in the human subject or in the rat is not infrequently lacking; and, in some instances where bacteriological examination has been made, it is not clear that physiological as well as cultural tests have been employed. Occasionally, indeed, it would seem that only microscopic examination had been made. In like manner, definite statement is in some instances made as to the presence or absence of sickness or mortality among rats; while, in other instances, no statement is made the one way or the other. In considering the evidence about to be given, it will be necessary to pay due regard to these *lacunæ* in the schedule of facts.

The facts which I have collected, as far as the sources of information at my disposal have permitted, cover a period of nine

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* This memorandum was written in the summer of 1903. Copies of it, translated into French, were presented to the delegates of the several countries represented at the International Sanitary Conference held at Paris October 10th—December 3rd, 1903.

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...ll, therefore, plague among rats was observed on 37 ships during ...he four years in question. As regards the 28, out of these 37, on ...hich both man and rats were affected, it may, in some cases at ...ast, be questioned whether the primary source of infection from ...hore was the rat or the human subject. To this point reference ...ill be made later. Be this as it may, however, these data seem ...o indicate that transference of infection from shore to ship is ...more likely to occur through man than by the rat. Nor do they ...point to a serious degree of danger of this sort, since only some ...nine vessels per year are recorded as having developed plague ...among rats on board.

In this connection, it is of interest to consider the number of vessels leaving Bombay, a plague-infected port, for ports out of India, during the period 1898–1901, on which plague, whether among rats or men, is known to have made its appearance after departure from Bombay. The measures taken at Bombay as regards these vessels prior to their departure were medical examination, by day and on shore, of every person proposing to sail by them; disinfection of clothing, bedding, and effects of native crew, third-class and deck-passengers; attention to the sanitary condition of the vessels, leading to such action as cleansing and disinfection of crew's quarters, cleansing of bilges, and, in the case of ships in ballast, the cleansing of 'tween decks and holds.

In the four years, 1898–1901, 3,408 vessels left Bombay for ports out of India. On the voyage plague appeared on board 20 of these vessels. It was observed in man alone in 16 of the 20; in both man and rats in three; and in one in rats alone. In detail, the figures are as follows:—

Years.	In Man alone.	In Rats alone.	In both Man and Rats.
1898...	5	—	2
1899...	4	—	—
1900...	3	—	1
1901...	4	1	—
1898–1901	16	1	3

[I note here, in fairness to Bombay, that it is not clear, in some of the above instances, that the infection had been derived from Bombay.]

These figures as regards Bombay shipping suggest, it will be seen, the same inference as do those concerning shipping in general. And they possess a special interest, since the measures I have quoted as in force at Bombay in respect of ships outward bound for ports out of India comprise nothing specially intended to secure destruction of rats on board ship. This notwithstanding,

known appearance of plague among rats on board these vessels was extremely rare.

There is another consideration to be borne in mind, the effect of which is to minimise still further, in relation with alleged appearances of plague among rats on board ship, the apprehended degree of danger of transmission of this disease by rats from shore to ship. In not a few of the instances which I have elected to class as "Plague among rats," because narrators of the circumstances chose to so regard it, the evidence of this depends wholly upon the existence of notable mortality among rats, or, at best, upon microscopical examination alone; while, in other instances, it is not clear that adequate bacteriological examination, physiologically confirmed, had been made. But we know, from experience in this country, that notable mortality among rats on board ship is not necessarily due to plague, but may be caused by other maladies in no way related to that disease. And we further know that one of these maladies is characterised by the presence in the rat of a micro-organism that cannot be clearly differentiated from that of plague by microscopic examination alone; and that, indeed, definite differentiation cannot be satisfactorily established without physiological experiment in addition to microscopical and bacteriological examination. So that it is open to serious doubt whether the numbers I have given of ships that have had plague among rats on board them should not be materially reduced.

But, on the other hand, it is claimed that plague may affect rats on board and yet remain unrecognised, since only a notable mortality among them is likely to attract attention, while the presence of plague among rats may not necessarily set up such a mortality. Certain observations that point in this direction will be cited at a later stage of this memorandum.

(2.) *The danger of transmission of infection from plague-infected rats to man on board ship.*

The number of ships on which plague is known to have occurred, among man or rats or both man and rats, during the period 1898–1901, according to the records I have consulted, is, as already stated, 95. The yearly distribution is as follows :—

Years.	In Man alone.	In Rats alone.	In both Man and Rats.
1898	12	1	4
1899.	13	—	5
1900...	16	—	[redacted]
1901...	17	8	11
1898–1901	58	9	28

These figures are subject to two criticisms of opposite intention. On the one hand, it may be contended that some of the instances classed as "man alone," were in reality instances in which there was unrecognised plague among rats on board. On the other, it may be claimed that in some instances the disease observed among rats was not plague.

In support of the first of these criticisms it might be pointed out that the proportion of vessels alleged to have had plague among rats is larger in 1901 than in any previous year, due, it may be alleged, to more careful search for suspicious sickness among these rodents. It is difficult to appreciate the just value of this criticism by reason of there being in many instances entire absence in the accounts given, of any statement as to whether or not there had been sickness among rats. In the 86 vessels (out of a total of 95) on which plague appeared in man or in both man and rats, the proportion in which definite statement is recorded as to the "health" of rats on board appears from the following table:—

Years.	Definite Statement.	No Statement.
1898	4	12
1899	10	8
1900	9	15
1901	14	14
1898-1901	37	49

There is nothing in the figures for the last three years of the period 1898–1901 which appears to justify belief that increasing watchfulness had led to detection of rat-sickness in an increasing proportion of vessels on which there was human plague; the figures for 1898, however, are more open to doubt. On the whole it seems reasonable to assume that, in most cases, no statement as to the health of rats implies that no sickness had been observed among them. This, however does not exclude the possibility, already referred to, of plague-sickness having been present among rats in a form not readily recognisable. It is, therefore, possible that there may have been instances among the 58 vessels where only human plague was recognised, in which rats also were affected.

In regard of the second criticism, that the disease observed among rats may not have been plague in all instances, it is to be noted that in the 28 ships in which both man and rats were affected, positive bacteriological evidence as to its nature in these rodents is recorded in seven instances only. As regards the nine vessels in which the disease affected rats alone, there is positive bacteriological evidence in six instances, and in two instances

microscopical evidence only. I do not think, however, that mere absence of positive evidence of this sort can properly be regarded as excluding presence of plague among rats; but such absence must be held to have weight when other circumstances tend to cast doubt upon the assertion that a particular rat-sickness was plague.

Subject to such allowance as may be made for these considerations, I proceed to examine in detail the figures I have given under this head.

As regards the 58 vessels on which plague is not known to have made its appearance save in man, these instances seem to point the moral, at present overlooked by many, that, whatever the degree of danger to persons on board ship from infected rats, the latter condition is not the greatest danger. So marked is the difference between the number of vessels (58) in which human plague only is recorded and the number (28) in which plague is stated to have occurred in both man and rat, that this proposition must, I think, stand, even if some transference had to be made from the first class to the second. These figures certainly do not support the contention that the rat is the chief agency by which plague is transmitted to man. That such view is erroneous is further indicated by consideration of the circumstances in which plague made its appearance on the 28 vessels in which both man and rat are stated to have been affected. As regards these vessels it has been too readily assumed that it was in all cases the rat that gave the disease to man; to the exclusion of the consideration that in reality man may have infected the rat. Again, the mere fact that one or two dead rats had been found on board a ship with human plague has been taken, without further evidence, as proof of there having been rat plague on board—with inference that here was the source of the human plague. I proceed—inevitably at some length—to cite instances.

The *Pei-ho* arrived from Crete at Marseilles on 4th December, 1901, with a soldier on board who had been ill three days; his malady was diagnosed, and bacteriologically confirmed, as plague. No other cases occurred on board either among the crew or the 69 passengers. After arrival, bacteriological examination of rats on board "revealed very suspicious signs." In this instance it was supposed that the man's infection had been derived from the rats on board, notwithstanding the fact that it is also stated that during the voyage no sick or dead rats had been observed in any part of the ship, and that the bacteriological examination of rats on arrival cannot be regarded as positive.

The *Simla* arrived at Southampton on 13th March, 1901, from the Cape of Good Hope, with a sick Lascar who had been under observation since 23rd February, two days after the vessel left Cape Town. At Southampton the case was recognised as plague (bacteriologically confirmed). It is said that some dead rats had been found on the vessel shortly after leaving Cape Town and that the Lascar, who was a baker's mate, had been in the habit of catching rats which came to feed on the flour and bread. Whether the rat-sickness was plague or not is uncertain, but, if it were so,

it appears on these facts that the Lascar infected the rats and not the rats the Lascar. There were no other plague cases on board.

The *Hiroshima Maru* arrived from Hong Kong at Yokohama on 3rd August, 1901, having been quarantined 10 days at Keelung, Formosa, on the way, on account of a case of plague having occurred on board two days after leaving Hong Kong. At Yokohama, dead rats were found in the hold, which, on examination, showed the plague bacillus. In this instance the man had doubtless contracted plague on shore at Hong Kong, where plague was prevalent at the time, and may have set up the disease among the rats on board.

The *Polis Mitylene* left Constantinople on 17th October, 1899, with 30 crew and 63 passengers for Trieste, where she arrived 27th October. On arrival the boatswain was complaining of illness, which was diagnosed later, and bacteriologically confirmed, as plague. There were no other cases on board. Dead rats were found in the lower hold ; they do not seem to have been bacteriologically examined. The cargo was wine, which had been fermenting, and had evolved much carbonic acid, which is stated to have suffocated these rats. The captain had, indeed, declared at Trieste that no live rats would be found on board, all having been asphyxiated by the carbonic acid evolved from the cargo. On this evidence, however, the death of these rats has by some writers been referred to plague.

The *Carlisle City* left Hong Kong 13th May, 1901, calling at Yokohama, which she left 29th May, called at Honolulu 11th June, and left Honolulu 13th June for San Diego, which she reached 22nd June. There was plague at Hong Kong and at Honolulu. One of the crew fell ill on 6th June and died on the 9th of what was diagnosed as jaundice. On 14th June, the day after leaving Honolulu, a sailor fell ill with fever and glandular swellings ; three more sailors and one passenger fell ill in the next four days with similar symptoms, and all died. It is stated that some dead rats had been found before the occurrence of these cases on board. At San Diego the ship was fumigated with sulphur, and in this way 21 rats were killed ; all were bacteriologically examined, but with negative results. In this case the evidence points to human plague contracted on shore at Honolulu—the first death probably not having been due to plague—and to the rat-sickness not having been plague.

The *Patna* left Bombay on 24th March, 1898, for the Persian Gulf. On 28th March a coal trimmer fell ill with "fever," and in the next few days three more cases (two among the crew and one a deck-passenger) occurred, one of which was definitely diagnosed as plague. Three of the four cases died. On 26th March the second saloon passengers complained of an unpleasant smell in the saloon, and on the 28th two dead rats were found behind the pipe-casing. It does not appear whether any bacteriological examination of these rats was made. In this case, even if these rats had died of plague, the evidence points rather to human infection at Bombay.

App. B, No. 1.

Memorandum on Rats and Ship-borne Plague; by Dr. T. Thomson.

There are other instances, which I forbear from giving at length, regarding which the unbiassed observer will find difficulty in accepting the view that the transmission of plague to man by the rat has been established. Notable among these are the *Laos*, the *Sénégal*, the *Ville-de-la-Ciotat*, and the *Friary*, in 1901; the *Dundee*, the *Highland Mary*, the *Marienburg*, the *South Garth*, the *Coromandel*, and the *Niger* in 1900; the *Berenice* and the *Equateur* in 1899; and the *Mehalla* in 1898.

If, however, the thesis be accepted that, in all the 28 instances of plague on board ship in both man and rat, the disease had been transmitted by the rat to man, it is of interest to inquire in what degree infection had in this way been conveyed. Investigation as to this shows that in 13 of these vessels there was only one human case on board; in three there were two cases; in five there were four cases; while in the remaining seven there were, respectively, five, six, seven, eight, nine, 17, and 23 cases. These figures do not suggest a high degree of infectivity of rat plague for the human subject, nor, therefore, so serious a danger to man as is commonly believed. This reflection is strengthened when regard is had to the duration of the voyage, and, therefore, of presumably sustained exposure of man to infection in some instances. For example, of the 13 vessels on which, in each instance, a single human case occurred, the voyage was, in six of them, of 20, 20, 21, 32, 35, and 40 days respectively. Among these the *Highland Mary*, which reached Liverpool on 27th August, 1900, 32 days out from Buenos Ayres, is of interest. One of the seamen fell ill on the 13th day after departure from Buenos Ayres, with what was diagnosed as plague at Liverpool. The captain stated that during the voyage he had observed rats "dying all over the ship." Of interest also is the *Marienburg* which reached Bremen after 40 days voyage from Buenos Ayres. Two days after her arrival one of the crew fell ill and died of what proved to be plague. It was stated that dead rats had been found on board at Buenos Ayres, and also during the voyage.

From this point of view, especial interest attaches to the nine vessels on which, during the four years, 1898–1901, plague is stated to have occurred among rats but not in man. In view of their importance, I give some account of each.

The *Y.* reached Diego Suarez 10th October, 1898, from Marseilles. Between Aden and Diego Suarez there was great mortality among the rats in the holds. The *Y.* subsequently went to Tamatave, Réunion, and Port Louis, and then returned to Europe. The *Y.* is accused of having given plague, through the medium of infected rats, to another vessel at Diego Suarez, and of having conveyed it, in like manner, to Tamatave, Réunion, and Port Louis. At no time, however, was there so much as a suspicious case of human illness on the *Y.* during her voyage.

The *Braila* arrived at Marseilles on 8th November, 1901, from the Danube, Black Sea, and Constantinople. On 9th November a rat on board was found, on bacteriological examination, to be infected with plague. The ship was fumigated with sulphur; in all 82 rats were destroyed, and bacteriological examination of these

is stated to have shown that one out of every two was plague-infected. All persons on board remained healthy.

The *Cambodge* reached Frioul on 4th October, 1901, from Constantinople. The captain and the doctor stating that there was a great mortality among rats on board, two were bacteriologically examined and found to be suffering from plague. The crew and passengers remained healthy.

The *Chios*, a Levant liner, arrived in Hamburg in December, 1901; a dead rat found on board proved, on bacteriological examination, to have died of plague. There was no human sickness on board.

The *Ile de la Réunion* left Bombay 14th August, 1901, and reached Dunkirk 20th September, proceeding thence to Havre, which she reached 2nd October. On 4th October dead rats were found on board, which, on bacteriological examination, proved to have died of plague. There was no plague among either passengers or crew.

The *Pergamon* arrived at Hamburg on 15th January, 1901 from Smyrna and Algiers. Bacteriological examination of dead rats found on board showed that these had died of plague. All persons on the ship remained healthy.

The *Rembrandt* arrived at Bristol on 20th January, 1901, from Smyrna; on the 22nd dead rats were found on board, and proved, on bacteriological examination, to be plague-infected. The vessel was fumigated with sulphur, and 226 rats were destroyed. There was no illness among persons on board.

The *Saghalien* reached Marseilles 7th November, 1901, from Constantinople. Next day a large number of putrefying rats were found on board, shown, on bacteriological examination, to have died of plague. The vessel was fumigated with sulphur, and in all 1,011 rats were destroyed, in addition to 150 found dead or sick prior to fumigation. There was no plague among persons on board.

The *Waialeale*, trading between Kauai and Honolulu, was found at the latter place, in October, 1901, to have dead rats on board. On microscopic examination these were stated to have died of plague. The master said that he had noticed dead rats on the ship for about three weeks. There was no human illness on board.

In these instances, it will be noticed, the voyage had, for the most part, been of considerable duration*: notwithstanding which plague was in no one of them transmitted from the infected rat to man.

(3.) *The danger of transmission of infection from ship to shore by plague-infected rats.*

Under this head I propose to consider, in the first instance, how far plague is known to have spread to places on shore in 1898–1901 from the 28 ships stated to have had both human plague and

* In some instances the exact dates of sailing could not be ascertained, and the probable duration of the voyage must, therefore, be gauged by the distance traversed.

rat plague on board, and from the nine ships stated to have had ra plague only.

From four of the 28 vessels above referred to, plague is stated to have spread to places on shore. But, as regards two of these viz., the *Friary* in 1901, and the *Niger* in 1900, the spread on shore is not alleged to have taken place through the medium of infected rats, but occurred from direct contact with sick persons. Indeed, as regards the *Friary*, bacteriological examination of rats on board at the port of arrival gave negative results; while, in the case of the *Niger*, it is not clear that, on the particular voyage in question, rats on board had plague. The *Centauro*, however, which reached Ascension on 26th April, 1899, is stated to have set up plague there through plague-infected rats on board making their way on shore. Four of the *Centauro's* crew were attacked by plague on the 27th and 28th April; they were taken ashore and three of them died. In the *Centauro's* hold, while cargo was being discharged, some 30 dead rats were found. A fortnight after her arrival, an epidemic was observed among rats on the Custom House premises. There was not at the time any suspicion as to the disease, among either rats or men, being plague. Plague was not, in fact, recognised in Ascension until the following September. Other ways in which the disease may have reached Ascension have been suggested; and it is not clear whether the *Centauro* was responsible or not for its introduction to this place.

The *Gironde* also, is credited by one authority (Dr. Borel) with having infected Lorenço Marques in 1898. She reached Lorenço Marques on 21st October, and when her holds were opened there large numbers of dead rats were found. After a week's stay she left, and five days later human plague appeared on board. It is affirmed that during discharge of the *Gironde's* cargo at Lorenço Marques infection was conveyed ashore by rats. Plague was recognised in this place towards the end of the following November. On the other hand it has also been alleged that there probably was plague, in unrecognised form, in Lorenço Marques at the time the *Gironde* called there; and that the *Gironde* was infected from Lorenço Marques.

It must be observed, however, that most of the 28 vessels under consideration had been fumigated at the port of arrival with a view to secure destruction of rats on board: which may be taken to have diminished the risk of infected rats making their way ashore. Among exceptions were the *Marienburg* and the *South Yarra*, in 1900, in which fumigation was not resorted to until after discharge of the whole cargo; seemingly also the *Dundee* in the same year; and, perhaps two or three others, in respect of which it is not clear what measures were taken.

As regards the nine vessels in which rat-plague alone was observed, the disease is alleged to have spread to places on shore in one instance, viz., the *F.*, account of which has been given on p. 324. So far as these places—Port Louis, Réunion and Tamatave—are concerned, it seems probable that plague appeared at Port Louis within a month of the *F.* having called there. Tamatave

seems to have been plague-infected about the time of that vessel's arrival—Réunion not for several months later. The *Y.* it will be remembered, never had any suspicious human sickness on board during her long voyage of some three months; and it may be doubted whether the rat disease really was plague. One of the crew attributed the rat mortality on the *Y.* to poison which he had laid down for them. In the remaining eight vessels no spread took place from ship to shore; and this notwithstanding that, in at least five of these vessels, the cargo had been partly or wholly discharged before the infected rats were discovered, and therefore, before any measures had been taken to secure destruction of rats. Indeed, in the case of the *Chios*, at Hamburg, part of the cargo had been conveyed into the interior. In none of these eight vessels, however, did plague attack the persons unloading or handling the cargo, nor is plague known to have made its appearance among persons or rats ashore.

In the *Revue d'Hygiène* of February 1903, Dr. Jacques, of the Port of Marseilles Health Service, gives an account of bacteriological investigations made by him as to the proportion of vessels on which there are plague-infected rats. The vessels kept under observation were those coming into Marseilles from infected places with, in some degree, others from countries not known to be infected. These investigations covered a period of 15 months, and their results appear from the following figures:—

Years.	No. of vessels examined.	No. of vessels found with plague-infected rats.
1901.—October-December	133	15
1902.—January-March	104	5
1902.—April-June	114	1
1902.—July-September	111	2
1902.—October-December	93	3
Totals	555	26

It will be seen that about five per cent. of these vessels were found to have plague-infected rats on board; the quarterly variations being from less than one per cent. to 11 per cent. It is interesting to note that no infection of persons on board took place in any of these 26 vessels, nor was there any known extension of the disease from ship to shore. I should add, however, that measures were taken to prevent rats on these vessels from gaining the shore, and that all were fumigated with a view to securing destruction of these animals.

But it is a striking consideration that, before the period when these investigations were undertaken, no human plague had been observed in Marseilles nor any plague in rats on shore, save on one occasion, when a limited outbreak occurred among these vermin in one of the docks. This is stated to have been rapidly and effectually dealt with, and no extension of the disease is known to have followed. And yet it seems fair to assume that vessels harbouring rats affected with unrecognised plague had been entering Marseilles for at least two or three years before: and probably not in smaller proportion, since plague was not less prevalent then than at the time of these experiments. The investigations of Dr. Jacques undoubtedly go to show that risk of shore infection by plague-infected rats on board ship has been greatly exaggerated; indeed, it is difficult to arrive at other conclusion than that such risk is small. In this connection I take the opportunity of quoting an observation made by Dr. Jacques on the question of disinfection of vessels entering port; an observation of interest in these days when there is a disposition to apply severely restrictive measures in consequence of undue fear of conveyance of plague by rats on ship-board. His observation is—"Si ces 26 navires justifiaient l'emploi d'un désinfectant énergique, il aurait été regrettable de détériorer inutilement les marchandises des 529 autres."

Our own experience at home is not without bearing on this question as to what degree of risk there may be of conveyance of plague infection from ship to shore by means of rats. In the earlier days of the present recurrence of plague in epidemic form, no measures whatever were taken as regards rats in our home ports; and, indeed, even to-day, such measures are, in most of our ports, limited to ships known to have plague on board. Yet, notwithstanding our enormous mercantile traffic with all parts of the world, extension of plague on shore has taken place in four instances only, viz., twice at Glasgow, once at Liverpool, and once at Cardiff. It is further to be noted that in the first outbreak of plague in Glasgow (in 1900), notwithstanding careful bacteriological examination of large numbers of rats, no single instance of rat infection was discovered; while, in the Liverpool outbreak in 1901, there was like absence of rat-infection. In Cardiff, however, plague made its appearance, in 1901, among rats on shore, but it was accompanied by only one human case. These facts, like others already cited, tend to suggest that, so far from the rat being the chief source of transmission of plague to man, it is of minor importance among the agencies, known or unknown, by which such transmission takes place.

Review of all the facts set out in the foregoing pages leads, in my judgment, to conclusion that the part played by the rat in transmission of plague to man, although real, falls far short of the importance which has generally been attributed to it. That it should be so over-estimated is a matter of serious practical moment, since such a view may lead to comparative neglect of other risks of infection and to the imposition of measures, in relation with rats, of unwarrantable stringency.

That the rat should have attained this position in the minds of many, as an agency in the propagation of plague, is easily comprehensible. The tracing of the causation of disease is ever present with the medical investigator; the rat suffers readily from plague, and is capable of transmitting this disease to man; and wherever man is, there the rat abounds. When, therefore, other cause of plague in man is not readily apparent, the tendency is to blame the rat, always there and notoriously liable to this malady. But we know, from the study of other infectious diseases, that, in this class of malady generally, infection is wont to spread in ways beyond our comprehension; in this respect, plague has taught us nothing new. It is only by impartial and thorough consideration of all the circumstances that the degree of importance of a particular agency of infection can be correctly estimated. My view as regards those who believe the rat to be the chief agency whereby plague is transmitted to man is that they have paid too much attention to individual instances, of an impressive character, in which the rat has given plague to man, and, thus unduly influenced, have failed to weigh the whole evidence, negative as well as positive.

I do not think it possible, on the data I have furnished, to estimate accurately the degree of danger of plague-infected rats gaining access from shore to ship or from ship to shore. These data, however, although not lending themselves to accurate estimate in this sense, may reasonably be considered to afford general guidance of no small importance. If the Bombay evidence be accepted, the first of these dangers is to be regarded as quite insignificant; if that of Dr. Jacques—and, I confess, I lean this way—be the truer index, both dangers loom somewhat larger. But, accepting the latter view, I cannot but think that, if due regard be paid to what has resulted both at Marseilles and in this country, the logical inference is that the risk of consequent outbreak of plague on shore from ship-borne rats is much smaller than is commonly apprehended.

No. 2.

App. B, No 2. Destruction of Rats and Disinfection on Shipboard: by Drs. Haldane and Wade.

Reports on the Destruction of Rats and Disinfection on Shipboard; by J. S. Haldane, M.D., F.R.S., and John Wade, D.Sc.

I.—Observation of the Clayton Process as used at Dunkirk; by Dr. Haldane.

By the courtesy of the Directors of the Anchor Line (Henderson Brothers) I travelled to Dunkirk, on October 6th, 1903, on the s.s. *Bavaria*, 3,009 tons register, to witness the disinfection of the vessel by the Clayton process, which is now employed at that port. The *Bavaria*, which is a cargo boat with accommodation for only a few saloon passengers, had arrived in London a few days previously from Calcutta, with a cargo partly for London and Glasgow but chiefly for Dunkirk. The cargo for Dunkirk and Glasgow, submitted to disinfection, was as follows:—

For Dunkirk:

11,186 bales jute,
2,730 bags poppy seed,
9,941 „ linseed,
2,226 „ grain (pulse).

For Glasgow:

1,091 bags pulse,
1,092 „ wheat,
1,092 „ peas,
1 box cheroots,
1 case wearing apparel,
1 package cigars.

The vessel arrived at Dunkirk about 11.30 a.m. on October 7th, and was stopped for medical inspection and disinfection at a special berth. A barge containing the Clayton apparatus was brought alongside immediately after the visit of the Port Sanitary Officials and the process of disinfection was commenced about 1.30 p.m. The Clayton apparatus consists of an iron furnace specially constructed to burn sulphur. Air is drawn through this by means of a Root's blower, the products of combustion being cooled by passing them through a cooling apparatus below the furnace before they reach the blower. They are driven onwards through a flexible rubber hose which can be introduced into any part of the ship. A return pipe brings air back from the ship to the furnace. The gas consists of the residual nitrogen of the air,

together with about 15 per cent. of sulphurous acid, and a good deal of sulphuric acid in suspension. The presence of the latter makes the mixture white and opaque. It is a good deal heavier than air. The apparatus used was of a small size, and the hose was of only 3½-inch diameter. Mr. J. B. Evans, of the Clayton Company, who was present at the operation, and afforded every facility for watching it, informed me that about 36,000 cubic feet per hour of gas were being delivered.

The men's quarters in the forecastle, together with the two small store-rooms below, in front of the collision bulkhead, were first treated, the hose being introduced through the door and down into the store-rooms. The operation was completed in about half an hour. The whole space appeared to be pretty well filled with the gas. Ten rats and thousands of dead cockroaches were lying about the floors, &c., after the operation, which appeared to have been very successful.

The several compartments of the vessel were next treated one by one, commencing forwards. The capacities in cubic feet of these compartments, each of which consisted of a hold and 'tween decks, were as follows :—

No.	Hold.	'tween Decks.	Total.
	Tons.	Tons.	Cubic feet.
1	1,369	524	79,720
2	1,779	699	99,120
3	817	335	46,080
4	1,393	637	81,200
5	941	557	58,240
	Total		364,360

Each compartment had four ventilators, about 1½ feet in diameter. Each ventilator opened into the 'tween decks, an inner tube, about 14 inches in diameter, being, however, continued down through the main-deck into the hold below, and ending at the lower side of the main-deck. As some space was left between the top of the cargo and the main-deck, and as there was also a free space between the cargo battens and the plates forming the sides of the hold, the gas could pass freely to the bottom of the hold on each side. The cargo itself was very closely packed.

The gas was introduced by putting the hose down a ventilator, the return pipe being usually put through a partly-opened hatch, and the other ventilators closed with canvas. The process was continued until the gas began to issue in a concentrated state from the hatch, an hour or more being usually devoted to each compartment; No. 4 compartment, which was empty, received less of

the gas. The saloon, with the cabins opening out of it, the galley, and the space under the poop-deck were similarly treated. The engine-room, stokeholds, and coal bunkers were not treated. The gas was introduced into the saloon through a ventilator in the entrance passage. It was dark at the time, and the electric lamps were left alight, so that I could observe through the windows the behaviour of the gas in the saloon. It gradually filled the room from below upwards, the upper surface of gas having a fairly well defined surface. Above this layer flies still alive could be observed until the upper level of the gas reached them, when they were killed.

In the holds which were full the gas would doubtless tend to pass down the free space at the sides of the hold between the cargo-battens and side plates, and thence inwards through the cargo. As the cargo was warm (the bags of seed had a temperature of about 100° F.), the air would naturally circulate down the sides and upwards through the cargo; and the introduction of a heavy gas, such as sulphurous acid, would increase this circulation. The cargo was, however, very densely packed, and it would probably take a long time for the gas to thoroughly penetrate. Unfortunately for the observations there were very few rats on the ship.

Before leaving Dunkirk I was able to examine Nos. 4 and 5 holds pretty thoroughly. No. 4 was practically empty when treated and was left with the ventilators and hatches closed for about 12 hours after the operation. After the ventilators had been open for several hours I descended to the bottom. One dead mouse and several dead crickets were seen lying on the limber boards at the bottom; living crickets were, however, heard chirping in both the 'tween decks and holds. The gas had thus not been sufficient to kill all the crickets—doubtless because the treatment had been too hurried. In No 5 hold, which had been full of jute and bags of seed, I also heard crickets chirping, but could not find either dead or living rats or mice. As to No. 1 hold, Captain Lindquister reported to me that two live rats and five mice were found and killed after cargo was discharged, and that several others were seen running about. In No. 2. hold three live mice were found and killed, and more were seen running about, besides a number of live crickets. As the holds were kept closed, except when the work of discharge was actually going on, it seems hardly possible that these animals could have got in after the operation of disinfection had been completed; and evidently the penetration of the cargo by the gas had been very imperfect, as no dead animals were found except in the empty holds. The work of discharging cargo was begun the morning after the vessel had been treated, and it was remarkable that there was scarcely any smell of sulphur in the loaded holds. As shown in the succeeding report by Dr. Wade, this was probably due to absorption of sulphur dioxide by the outer portion of the cargo.

With regard to the question of damage, the cargo, so far as I was able to judge from superficial examination, appeared to be quite uninjured. Much evidence as to absence of damage in certain common articles of cargo has been presented in a paper by

Dr. Duriau, Officier de Santé at Dunkirk, and M. David, Chemist to the Chamber of Commerce, Dunkirk. These gentlemen kindly showed me a number of samples of coloured fabrics and various other articles which had been thoroughly exposed to the action of gas from the Clayton apparatus, together with the corresponding control samples; and the appearance of the samples entirely bore out their published statements.*

In the saloon and staterooms I could observe no evidence of appreciable damage, although everything, including articles of clothing, had been left exposed to the gas. The tarnishing of brass fittings was quite superficial and easily removed. On the other hand, the smell left behind in the bedding and various woollen materials, such as cloth, &c., was extremely unpleasant. I slept in one of the staterooms after the disinfection, and although the bedding had been aired on deck, and all windows and doors left open for several hours, the atmosphere was most unpleasant. Two ladies who slept on board suffered considerably from catarrh of their air passages, caused by sulphurous acid given off from the bedding. The smell of sulphurous acid soon passed off, but for a long time afterwards the bedding and clothes had a most unpleasant smell in spite of constant airing. The smell was due to some other compound than sulphurous or sulphuric acid, as it was distinctly suggestive of putrefaction. Captain Lindquister reported to me from Cardiff, ten days after the disinfection, that "the smell is still with us," and my own clothes, which had been left in one of the staterooms, still smelt very distinctly three weeks after disinfection, and in spite of all efforts to get rid of the smell by airing.

The cause of this smell is dealt with in the succeeding report, from which it will be seen that the sulphur used at Dunkirk probably contained selenium.

There is no doubt that the sulphurous acid failed to penetrate the cargo in the holds of the *Bavaria*. If even 0·5 per cent. of sulphurous acid (one thirtieth of the percentage in the gas sent in) had been present in the air in the interstices of the cargo the rats and other animals would, as will be shown in the report by Dr. Wade which follows, have been all destroyed. As the animals were not destroyed we may also be sure that the cargo was not disinfected. The failure of the gas to penetrate was evidently due to insufficient time being given to the operation, although as a matter of fact it was passed into each loaded hold until it issued from the ventilators or hatches in a concentrated state. Any gas, if passed in too quickly, would flow over the surface of the cargo and escape by the nearest opening, but apart altogether from this fact sulphurous acid requires a very long time to penetrate, since, as shown in the following report by Dr. Wade, it is liable to be absorbed by such articles of cargo as seeds, grain, jute, &c. Thus, even when the other (non-poisonous) constituents of "Clayton gas" have completely penetrated the cargo the sulphurous acid remains behind, absorbed by the outer layer, and the rats, &c., in this way escape. It would certainly have been

* Revue d'hygiène, Vol. XXV., No. 6, 1903, *see also* Dr. Wade's Report, below.

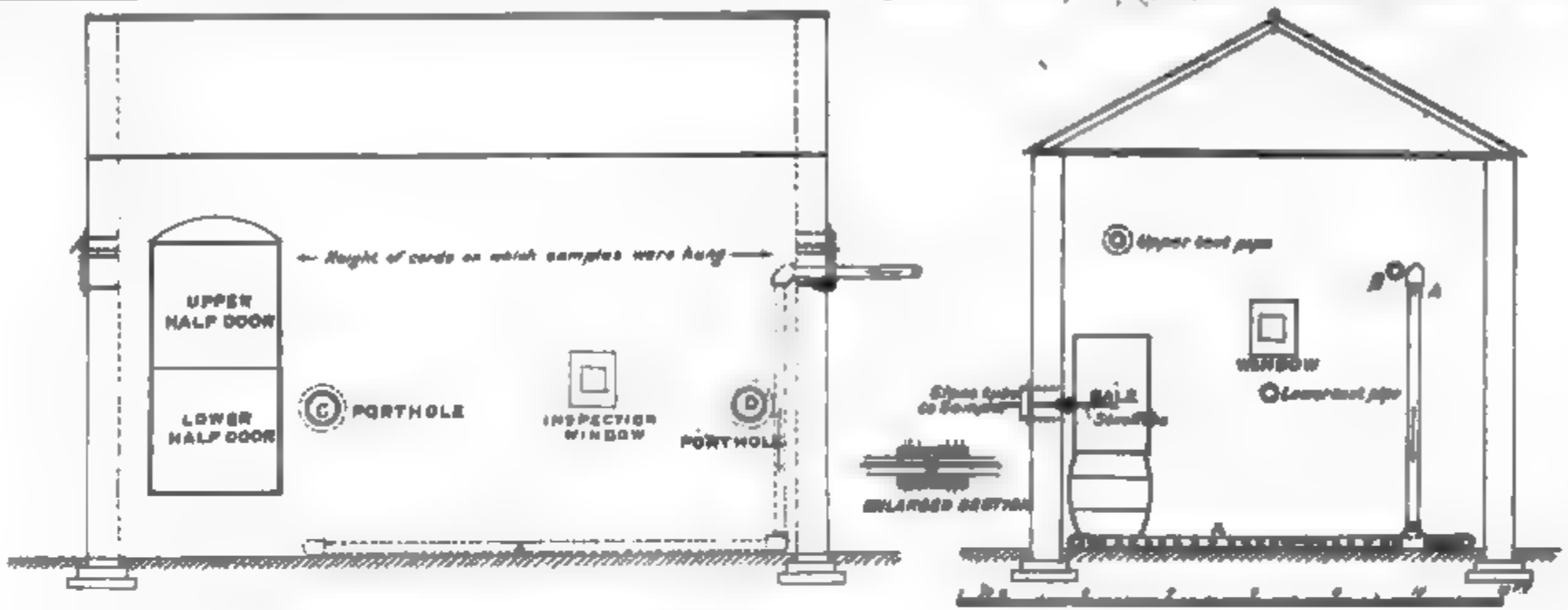
better to treat all the holds simultaneously with a smaller flow of gas into each, and utilise the time so gained by devoting a much longer time to each individual hold; but as to the time really required to enable the sulphurous acid to penetrate sufficiently the available data do not enable me to form any very definite opinion.

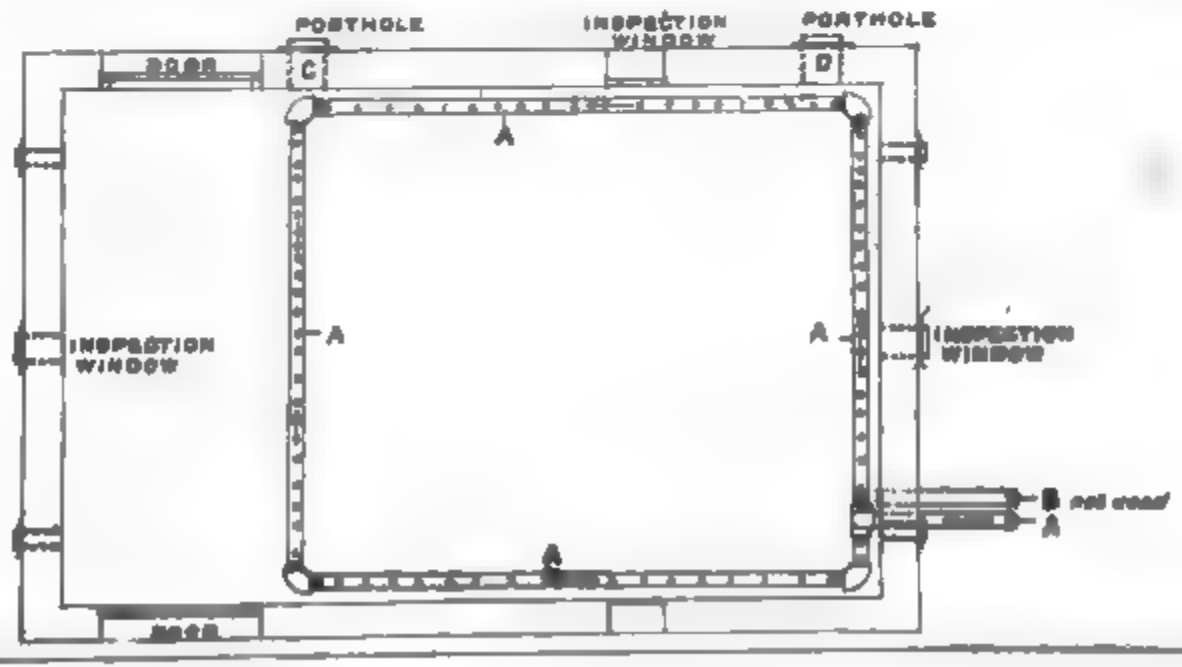
A further point which is perhaps worth referring to is this. The fact that the great bulk of the seeds, grain, jute, &c., had practically no smell of sulphurous acid when unloaded seems to indicate that but little of the gas had been actually absorbed during the short period of treatment. Had the treatment been sufficiently long to be effectual it seems probable that these articles of cargo, like the bedding, &c., in the cabins, would have continued to gradually give off sulphurous acid for some days. A good deal of trouble would thus have been experienced by the men in unloading the cargo, and special means might have been needed to keep the air sufficiently clear to enable them to work.

The failure of the Clayton process as applied to the holds of the *Bavaria* under the conditions of the trial at Dunkirk was evidently no exceptional fact. In their Report to the Minister of the Interior on the Destruction of Rats on Shipboard (1902), Prof. Proust and Dr. Faivre state the results obtained in the disinfection by the Clayton process of the holds of seven loaded vessels of from 1,400 to 4,000 tons. Only 17 dead rats and mice (an average of about one rat or mouse in every two holds) were found afterwards. An equal number of living rats and mice were reported to have been seen, and possibly far more were actually present. Living insects were also reported to have been found in numerous cases. The time devoted to the process was almost the same as in the case of the *Bavaria*. Some of the holds were probably empty when treated.

From all the evidence at present available I have come to the conclusion that while it is evident that the Clayton process is most effective in destroying rats and other vermin in cabins, empty holds, and other similar places on shipboard, there is no satisfactory evidence as yet that it is practicable, without considerable delay and inconvenience, to make it equally effective in holds which are full. The usual treatment of about an hour for each hold is quite ineffective in destroying the rats, mice and insects. In any further trials several hours should be devoted to each hold.

The process was carried out at Dunkirk, not by the sanitary authorities as formerly, but by the Clayton Company. The use of the Clayton apparatus had, however, been recently rendered compulsory where it existed at French ports, by a decree of the Minister of the Interior, dated 21st September, 1903. The fee charged for disinfecting the *Bavaria* was £44, this being charged to the owners of the vessel. As the vessel was of 3,000 tons register the charge was at the rate of about 3½*d.* per registered ton. Representatives of owners expressed to me considerable dissatisfaction as to the owners having to bear this charge, particularly as, until quite recently, the charge for even a large vessel was less than £8.





PLAN AND ELEVATIONS OF EXPERIMENTAL BUILDING AT BLACKWALL

In concluding this report I should like to acknowledge the valuable assistance and great courtesy of Captain Lindquister, the officers of the *Bavaria*, and Mr. Seligman, the agent of the Anchor Line at Dunkirk. I am also greatly indebted to Dr. Duriau, Director of the Sanitary Service at Dunkirk, and to Dr. Loir, of Paris, both of whom gave me much valuable information and greatly furthered my investigation.

II.—EXPERIMENTS ON THE CLAYTON PROCESS AND SULPHUR DIOXIDE AS APPLIED IN THE DESTRUCTION OF RATS, AND IN DISINFECTION; BY DR. WADE.

In accordance with instructions received from the Medical Officer of the Local Government Board, I have carried out a number of experiments on the mode of action of the Clayton process of disinfection, and of sulphur dioxide.

The principal objects of inquiry were—

(1.) The percentage of sulphur dioxide required to kill rats and insects in a reasonable time.

(2.) Its action on pathogenic bacteria, especially those of plague.

(3.) The manner in which sulphur dioxide and "Clayton gas" penetrate cargo.

(4.) The damage, if any, likely to be done to the cargo and appointments of a ship during the process.

For the observations in which the Clayton gas itself was used, an experimental plant erected on a wharf at Blackwall was hired from the Clayton Company, who placed all their resources at my disposal. I am especially indebted to Mr. T. A. Evans, the Secretary of the Company, who readily furnished me with much information, and to Messrs. J. B. Evans and D. N. Hunt, Chief Engineer and Assistant Engineer, who were untiring in meeting my special requirements. I must also express my thanks to Captain Smith, the Superintendent of the wharf, for many courtesies which materially lightened my work.

The plant had been designed for demonstrating the fire-extinguishing properties of the gas, but was readily converted to the present purpose. It consisted of a special generator, the blower of which was driven by an oil-engine. The gas was delivered at the rate of about 100 cubic feet per minute into the lower part of a brick-built shed, having a slate roof of ordinary type.* The delivery pipe A, which was perforated with large

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* I have to thank Mr. Hunt, of the Clayton Company, for the drawings of this shed.

holes for the escape of the gas, lay on the cement floor of the shed. There was a return pipe B for air from the upper part, but this was not used, as the air displaced by the heavy gas readily escaped through the eaves. Access to the shed was obtained through two doors, which were closed and pasted up during each experiment. Small articles previously fastened to sliding boards could be withdrawn through port-holes C D at any time.

The Clayton gas is generated by burning sulphur in a sheet-iron furnace under forced draught. At the commencement of the operation, when the sulphur is only partially melted, the gas is fairly clear, and consists of sulphur dioxide, with the residual oxygen and nitrogen of the air, and a little carbon dioxide derived from the methylated spirit and tow used to ignite the sulphur. The temperature is quickly raised by the heat of combustion, the sulphur melts and boils, and the combustion is transferred to the sulphur vapour, which passes at a dull red heat into the upper part of the generator. Under these conditions a considerable amount of sulphur trioxide is formed, which remains suspended in minute particles when the gas is cooled, rendering it white and opaque. These particles settle rapidly when the gas is at rest, and uniting with moisture cover all exposed horizontal surfaces with a film of sulphuric acid.

The following table gives some typical analyses of the clear gas :—

COMPOSITION BY VOLUME OF THE CLAYTON GAS AFTER DEPOSITION OF SULPHUR TRIOXIDE.

——	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Sulphur dioxide	7·9	14·0	6·5	8·2	8·4	10·2	12·3	13·3	14·0
Oxygen... ...	12·3	6·0	12·0	11·8	11·9	8·4	7·0	5·8	5·7
Nitrogen ...	79·8	80·0	81·5	80·0	79·7	81·4	80·7	80·9	80·3

Samples I. and II. were taken at the outlet of the generator ; the others were taken from the shed at a height of four feet from the floor.

Air contains	Oxygen	20·9
	Nitrogen	79·1

When sulphur burns to sulphur dioxide, there is no alteration in the volume of the air, or the percentage of nitrogen it contains, as the sulphur dioxide occupies the same volume as the oxygen consumed. The above analyses show an increased amount of nitrogen, especially in the shed. This is partly due to the elimination of oxygen as sulphur trioxide, which, as a solid, has practically no volume, and in the shed also to the absorption of sulphur dioxide by the various articles under treatment.

The amount of sulphur trioxide in the gas when the generator was working steadily,* and delivering about 14 per cent. of sulphur dioxide, averaged 25 grams per cubic metre, equivalent to about 6 per cent. of the total sulphur: this proportion is similar to that which is obtained by the combustion of iron pyrites in the manufacture of sulphuric acid. The excess of nitrogen in the gas (Analysis II.) requires sulphur trioxide equivalent to 3·3 per cent. of the total sulphur in the gas. The excess of nitrogen in the shed would require more than this on an average, whereas, owing to the rapid subsidence of the sulphur trioxide, less was actually present.

It is claimed by the Clayton Company that the gas contains "an unknown higher oxide of sulphur of great toxic power." The claim appears to be based on the deficiency of oxygen, or what is the same thing, the excess of nitrogen in the gas. The excess of nitrogen in the outlet of the generator is, however, more than accounted for by the percentage of sulphur trioxide actually present: and the larger excess of nitrogen which is found in the gas after it has been in contact with materials under fumigation is due to the extensive absorption of sulphur dioxide by the materials (compare p. 345 *et seq.*).

I.—The Toxic Power of the Gas.

(a.) *Personal experience.*

The Clayton gas is very opaque, objects only two feet inside the shed being invisible when the door was opened. When the generator was working freely the sulphur gas streamed from under the eaves as a white fog which on calm days fell rapidly to the ground, and then spread slowly like mist. On windy days it was impossible to work except on the windward side of the shed, the gusts of gas blown from the building rendering the air in the immediate neighbourhood quite unbearable.

In order to determine the minimum percentage of sulphur dioxide which could be endured I made experiments on myself. After the shed had been fully charged with gas the door was opened, and as soon as the interior could be seen I endeavoured to enter and take a sample of the air. I did not succeed in doing this until the sulphur dioxide had fallen to 1·2 per cent., and then with difficulty, as I could scarcely see owing to excessive smarting of the eyes. The gas was practically irrespirable, and I had to go outside while the sample was filled.

A little later, when the sulphur dioxide had fallen to 0·6 per cent., the smarting of the eyes although still painful was no longer so acute as to interfere with vision, and the air could be breathed with some difficulty. In this case in marked breathing and nasal catarrh the chief symptoms were severe headache

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* The sulphur trioxide was estimated in a specially devised modification of Lunge and Reinche's method.

Similar results were incidentally obtained at other times. The mechanic in charge of the generator had apparently become more accustomed to the gas, as he did not seem to experience much inconvenience in an atmosphere 0·1 per cent. of sulphur dioxide, and stayed in it for several minutes apparently without any subsequent ill-effect.

The smell of the gas was very perceptible at 0·01 per cent., or one part in 10,000. Men working on board a ship undergoing disinfection by the Clayton process would therefore have ample warning of the approach of the gas, and in spite of its very toxic character, little risk of accident would be incurred. The opacity conferred by the sulphur dioxide is very convenient practically, as one is able to see currents of the gas approaching in time to avoid them.

(b.) *Experiments on Rats.*

The toxic effect of sulphur dioxide was ascertained by observations on rats and insects, for the former of which I am indebted to Dr. M. S. Pembrey, Lecturer on Physiology at Guy's Hospital.

The fatal percentage evidently being small, the experiments were made with sulphur dioxide liberated from a syphon of the liquefied gas, as it was found impossible in practice to control the percentage in the shed with the degree of accuracy required.

The animals under observation were confined in a tin-plate box, which was closed by a glass plate at the top, so that their condition could be observed throughout the experiment. A sufficient current of air charged with sulphur dioxide was drawn through the box, the percentage of the dioxide being determined at frequent intervals. Dr. Pembrey made the observations on the animals, and I was responsible for the maintenance and analysis of the air supply. I append Dr. Pembrey's account.

1. Large female rat. Weight 155 grams. Sulphur dioxide rose steadily from 0·5 to 1·2 per cent. Death in 27 minutes.

> The animal at once showed signs of distress, gasping and soon becoming listless. It experienced a slight convulsion at 11 minutes, and died after a violent convulsion in 27 minutes. The cornea of the eyes was turbid after death, the blood dark purple, and the lungs inflamed and full of frothy mucus. The symptoms are those of an irritant poison.

2. Female rat. Weight 130 grams. Sulphur dioxide varied between 0·22 and 0·34 per cent. Death in 1 hour 50 minutes.

> The animal at once commenced to breathe with deep gasping respirations. After 4 minutes the eyes were covered with a film and showed lachrymation. At 23 minutes it experienced a slight spasm. There was no further change for an hour, when violent shivering and spasms set in. At 1 hour 48 minutes

the animal became unable to stand, and death ensued after a violent convulsion 2 minutes later. After death the eyes were turbid and protruded, and there was congestion of the lungs and larynx, although less markedly than in the first case. The right auricle of the heart was still beating when the body was opened, although respiration had ceased 25 minutes before, and the body was cooling rapidly.

3. Young male rat, 7 weeks old. Weight, 22 grams. Sulphur dioxide rose from 0·17 to 0·21 per cent. Death in 37 minutes.

The animal was at once affected, respiring with gasps, and with pinched thorax. At 30 minutes it became unable to stand, and 7 minutes later was dead. There was no spasm or convulsion at any stage. On opening the body 15 minutes after death, the whole heart was still beating feebly. The lungs were congested, but there was no obvious change in the larynx.

4. Female rat. Weight, 140 grams. Sulphur dioxide varied between 0·03 and 0·07 per cent. Recovery after 2 hours' exposure.

The animal was at once affected and showed signs of irritation of the nose and eyes. It kept very quiet, and respired somewhat slowly, with occasional gasps. When removed from the gas it showed no abnormality, either at the time or subsequently.

5. Large male rat. Weight, 262 grams. Sulphur dioxide varied between 0·1 and 0·12 per cent. Recovery after 3 hours' exposure.

The animal was at once affected, respiring with pronounced gasps, and occasionally shivering. At the end of two hours it was breathing nearly normally, but the eyes protruded and were slightly turbid. When removed from the gas after three hours' exposure it respired spasmodically for some minutes, but showed no other abnormality. Next day the skin felt dry and hot, and the animal was obviously ill, but the rectal temperature was subnormal; it had completely recovered by the following day, and the outer layer of the turbid eye sloughed some days later.

6. Female rat. Weight, 140 grams (same as No. 4, seven days later). Sulphur dioxide varied between 0·15 and 0·17 per cent. Recovery after 4 hours' exposure.

The symptoms were the same as before, the gasping being especially marked. The animal experienced a slight spasm at the end of 2 hours. When removed from the gas after 4 hours' exposure, its behaviour was normal, both at the time and afterwards.

7. Large male rat. Weight, 262 grams (same as No. 5, eleven days later). Sulphur dioxide varied between 0·27 and 0·38 per cent. Death in 1 hour 27 minutes.

The animal respired with pronounced gasps, but there was a marked absence of nervous symptoms until a few minutes before death, when there were repeated spasms, terminating in a prolonged convulsion.

8. Very large male rat. Weight, 315 grams. Sulphur dioxide 7 per cent. Death in 7 minutes.

The animal respired with deep gasps. Convulsions commenced after 5 minutes, terminating fatally 2 minutes later.

SUMMARY OF RESULTS WITH ADULT RATS.

Percentage of sulphur dioxide.	Duration of Experiment.	Result.
0·03-0·07	3 hours	Recovered at once.
0·10-0·12	3 hours	Recovered next day.
0·15-0·17	4 hours	Recovered at once.
0·22-0·34	1 hour 50 minutes ...	Died.
0·27-0·28	1 hour 27 minutes ...	Died.
0·5 -1·2	27 minutes	Died.
7·0...	7 minutes	Died.

The maximum percentage which can be borne by an adult rat without a fatal result is thus about 0·2, which agrees very well with my personal experiences, so far as these go. Young rats are evidently very much more susceptible.

It may be safely concluded that the uniform diffusion of 0·5 per cent. of sulphur dioxide through a hold will kill the rats within 2 hours. The allowance of 6 or 7 hours starting at 10 to 12 per cent. recommended by the Clayton Company is therefore ample, *provided that the gas penetrates into every part of the cargo* (*v. infra p.* 349).

(c.) *Experiments on Insects.*

I made observations on young and adult cockroaches, and on fleas.

1. Young cockroaches. Sulphur dioxide 0·4 per cent. Death in 30 minutes.

Thirteen young cockroaches were placed in a large flask of air (1·6 litres) containing 0·4 per cent. of sulphur dioxide. They were very quickly affected, running in small circles, as if partially paralysed, and then turning on their backs. Spontaneous movements ceased after 7 minutes: five of the insects were still alive after 13 minutes, but 2 minutes later none showed any sign of activity. On removal from the gas, one insect moved feebly. Next day, two had completely recovered; one had partially recovered but ran in circles; two were dead, and the remaining eight moved feebly when irritated. On repeating the treatment for 30 minutes, none of the insects survived.

2. Adult cockroaches. Sulphur dioxide 0·4 per cent. Death in 1½ hours.

Six large cockroaches were placed in a similar flask, into which 0·4 per cent. of sulphur dioxide had been introduced. The insects were abnormally active for a minute or two, and then suddenly became still. After 30 minutes' exposure they were still alive, but very feeble; three were apparently dead after 45 minutes, but the remaining three still showed signs

of life. In 1¼ hours only one showed any sign of vitality, and at 1½ hours all were apparently dead. The insects were then placed in fresh air; one had partially recovered 4 hours later, but was very feeble, and although supplied with food died in three days.

3. Fleas. Sulphur dioxide 0·4 per cent. Death in 30 minutes.

Thirteen large dog fleas were placed in a similar flask, into which the requisite amount of sulphur dioxide was then introduced. With one exception they ceased to jump in 9 minutes, and merely wriggled about. In 20 minutes eight had ceased to move, and 5 minutes later three were still wriggling in small circles as if partially paralysed. In 30 minutes twelve were dead, and the thirteenth was very feeble; on blowing in fresh air it recovered to a certain extent, and was alive and fairly active the next day when it escaped.

It may be safely concluded that the uniform diffusion of 0·5 per cent. of sulphur dioxide throughout a hold will kill the insects within 2 hours.

II.—Experiments on Bacteria.

I am indebted for the various cultures to Dr. J. W. Eyre, F.R.S.E., Bacteriologist to Guy's Hospital. They were enclosed in numbered glass tubes, and after exposure to the gas or reservation as controls were returned to him for examination. At his request, in order to obtain an unbiassed verdict, I did not inform him as to the treatment to which they had been respectively subjected. I append Dr. Eyre's account of his procedure.

Micro-organisms employed in the Tests.

1. *Bacillus typhosus* isolated from the spleen of a fatal case of enteric at Guy's Hospital.

2. *Vibrio choleræ Asiaticæ*, obtained from the Institut für Infektionskrankheiten, Berlin.

3. *Bacillus pestis bubonicæ*, from the same source as 2.

4. *Bacillus dysenteriæ* (Shiga), from the same source as 2.

5. *Bacillus anthracis* (spores), grown from a culture isolated from a case of malignant pustule in man at Guy's Hospital.

All five organisms were perfectly typical in their morphology and biology.

Preparation of Cultures for purposes of Tests.

1–4. The micro-organism was planted on the sloped surface of nutrient agar, in a large tube, and grown aërobically at 37° C. for 24 hours. The entire growth was then scraped from the surface of the medium, and emulsified in 3·5 cc. of a sterile solution of salt (0·6 per cent.) in distilled water. Strips of previously sterilised cigarette paper and filter paper, about 5 mm. by 3 mm., and small pellets of sterile, absorbent, cotton-wool were then soaked in the emulsion for a few minutes, the superfluous moisture being then drained off, and the strips and pellets dried as quickly as possible in a vacuum over sulphuric acid. 5. The anthrax emulsion, prepared from a 7-day old agar culture, was absorbed in sterilised wool-yarn, and dried.

Each piece of paper or yarn and each pellet of cotton-wool was transferred to the interior of a separate, numbered, short length of glass tubing (15 mm. by 5 mm. bore), which had been previously plugged loosely at both ends with cotton-wool and sterilised by dry heat.

The plugged tubes containing the micro-organisms were then delivered to Dr. Wade.

Method of testing Vitality of Organisms after Exposure to Gas.

On receiving the tubes containing the infected paper and wool from Dr. Wade, the infected material was removed by means of sterile forceps, and at once introduced into a tube containing a suitable nutrient medium, Dunham's peptone solution in the case of the cholera-infected material, and ordinary nutrient broth in the case of material infected with the other bacteria. The culture tubes were numbered to correspond with the exposure tubes, and incubated aërobically at 37° C. These cultures were examined at intervals of 24 hours until the expiration of 7 days.

Identification of Organisms resisting Exposure to the Gas.

Merely noting growth after incubation was not considered sufficient, and steps were taken to prove the identity of the organism causing that growth with the organism originally employed to infect the material. With this end in view, in the case of micro-organisms 1–4 :—

a. Cultures were examined macroscopically and microscopically after the addition of corresponding "anti"-sera of high value, in dilution of 1 : 1000.

b. Cultures were planted on nutrient agar.

c. Cultures were tested after 7 days for the presence of indol.

The above tests were applied to each of the four micro-organisms. In addition, *B. pestis* was grown upon old agar medium to ascertain the presence of involution forms, and in broth to detect the formation of streptobacilli.

In the case of culture 5 :—

d. The growth obtained from the impregnated yarn was sub-cultivated on various media, and its identity with *B. anthracis* thus established.

No attempt was made to determine whether the loss of vitality of the cultures was preceded by diminished pathogenicity, as is known to occur with *pneumococcus* ; such results could only be obtained by direct inoculation of animals.

The culture tubes received from Dr. Eyre were wrapped separately in tissue paper, and sealed up in sets in ordinary envelopes. The numbers on the tubes were noted, and checked again on opening the envelopes after treatment. Each envelope contained a complete set of the cultures under examination in the particular experiment, so that the members of each set received identical treatment. The envelope was wrapped up in several thicknesses of cotton wadding, and then made into a small parcel with wrapping-paper. Finally, each parcel was wrapped in several thicknesses of blanket, making a bundle about 9 inches long and a little less in diameter. The bundles were tied to the sliding boards already mentioned, so that they could easily be withdrawn from the shed after any desired exposure.

Upwards of 300 tubes were dealt with, and the results, as compiled from Dr. Eyre's reports on the numbered tubes are

appended. The sign + indicates survival of the organism, the sign 0 that it was destroyed. In a few instances some of the controls were dead, owing no doubt to too prolonged desiccation, and these sets were rejected.

(a.) *Exposure to Clayton Gas.*

First Series.

Time of Exposure.	Percentage of Sulphur Dioxide.	Organism.	
		Plague.	Typhoid.
Nil	(Controls)	+	+
2 hours	8	0	+
3½ hours	8	0	+
4½ hours	8	0	+
5½ hours	11	0	0
6 hours	11	0	0

The plague microbes were destroyed in less than 2 hours, but the typhoid required 5 hours' exposure.

Second Series.

Time of Exposure.	Percentage of Sulphur Dioxide.	Organism.				
		Plague.	Typhoid.	Cholera.	Dysentery.	Anthrax.
Nil	(Controls)	+	+	+	+	+
1 to 2 hours ...	7	0 0	+	0 +	+	+ +
2½ to 3½ hours	7	0	0	+	0	+
4½ hours ...	8	0	0	+	0	+
5 hours... ...	9	0	0	0	0	+
6 hours ...	10	0	0	0	0	+
7 hours ...	11	0	0	0	0	+

The plague and dysentery microbes were destroyed in less than 1 hour, and the typhoid in less than 2½ hours; but the cholera

microbes (neglecting the result at 1 hour, which was not confirmed by subsequent experience) were more resistant, and required 5 hours. The anthrax spores remained unaffected even by 7 hours' exposure.

Third series.

Time of Exposure.	Percentage of Sulphur Dioxide.	Organism.			
		Plague.	Typhoid.	Cholera.	Dysentery.
Nil	(Controls)	+	+	+	+
½ hour	5	+	+	+	+
1½ hours	14	+	0	+	0
2 hours	12	0	+	0	0
2½ hours	12	0	0	0	0
5 hours	15	0	0	0	0

The dysentery microbes were destroyed in less than 1½ hours, and the plague and cholera in less than 2 hours; the typhoid resisted for 2 hours.

(b.) *Exposure to Sulphur Dioxide diluted with Air.*

Fourth Series.

The cultures were taken from the same batch as the third series.

Time of Exposure.	Percentage of Sulphur Dioxide.	Organism.			
		Plague.	Typhoid.	Cholera.	Dysentery.
Nil	(Controls)	+	+	+	+
½ hour	10·5	0	+	0	0
1 hour	10·5	0	+	0	0
2 hours	10·5	0	0	0	+ 0
3 hours	10·5	0	+	0	0
7½ hours	10·5	0	+	0	0

The plague and cholera microbes were destroyed in less than three-quarters of an hour; they had been kept dry a day longer than those of the third series, and may have been somewhat enfeebled by the prolonged desiccation; the plague results, however, were substantially confirmed by those of the next series. The dysentery was also destroyed very quickly, with the exception of a single specimen, which undoubtedly survived 2 hours' exposure. The typhoid cultures proved much more resistant, and although some were destroyed by 2 hours' exposure, others survived 3 hours, and to a certain extent, 7½ hours' treatment: but the cultures exposed for 7½ hours grew very scantily.

Fifth Series.

Time of Exposure.	Percentage of Sulphur Dioxide.	Organism.	
		Plague.	Typhoid.
Nil	(Controls)	+ + + +	+ + + +
2 hours	5·5	0 0 0 0	+ + + +
25 hours	5·4	0 0 0 0	0 0 0 0

None of the plague cultures survived exposure for 2 hours, even at the comparatively low percentage of sulphur dioxide employed. The majority of the typhoid cultures grew vigorously after the same exposure; none were destroyed, but a small proportion grew scantily. None of the typhoid cultures survived 25 hours' exposure.

Sixth Series.

Time of Exposure.	Percentage of Sulphur Dioxide.	Organism (Typhoid) in Sulphur Dioxide diluted with	
		Dry Air.	Moist Air.
6 hours	0·5	+ +	+ 0
16 hours	0·5	+	0
6 hours	1·9	+ +	+ 0
16 hours	1·9	0	0
Nil	(Controls)	+ +	+ +

Typhoid microbes grew vigorously even after 16 hours' exposure to air containing 6·5 per cent. of sulphur dioxide, when the air contained merely the ordinary amount of moisture; but they were all destroyed when the air had been saturated with moisture before introducing the sulphur dioxide, and some of them were destroyed in 6 hours under these conditions. With the higher percentage of 1·9 all the cultures were destroyed by 16 hours' exposure, whether the air was dry or moist; but at 6 hours none of the exposed cultures was affected when the air was dry, although some were destroyed when the air was saturated with moisture.

Before the cultures could be affected in the above experiments the gas had to penetrate many layers of material, viz., several thicknesses of blanket and wrapping paper, a mass of cotton wadding, several thicknesses of tissue paper, and finally the tightly-packed cotton-wool plugs of the culture-tubes. The conditions are as drastic as any that would be likely to occur in practice.

As a still more stringent test, two packages made up in the same way were placed in a steel trunk loosely filled with clothes. One of the packages was buried among the clothes, and the other was placed on top of them covered by a blanket. The trunk was then locked, so that the only means of access of the gas was through the space between the body and its somewhat badly-fitting lid. The trunk was placed in the shed during the exposure of Series III., and remained for some time afterwards while the shed was being aired.

The clothes smelled strongly of sulphurous acid when the box was opened, and were in places superficially discoloured by sulphuric acid (*v. infra*, p. 356). The gas had therefore penetrated into the trunk, although it was impossible to say to what extent.

The typhoid and plague cultures survived in both packages, whilst the cholera and dysentery microbes were destroyed. This test is beyond the requirements of practice, as boxes could always be opened for disinfection.

The results of the later series are interesting in view of the claim of the Clayton Company that gas generated by their process is more efficient as a bactericide than pure sulphur dioxide diluted with air. It is claimed that the gas contains a toxic higher oxide of sulphur, and that the sulphur trioxide increases the penetrative power of the gas, and at the same time exerts its destructive action on life.

I have already alluded to the question of this alleged higher oxide of sulphur. Analysis of the air contained in the wadding wrappings of the culture tubes, and also of the wadding itself, showed conclusively that no trace of sulphur trioxide or sulphuric acid, or of any sulphur compound other than sulphur dioxide was present. The gas to which the microbes were exposed was simply sulphur dioxide. I shall revert later to the singular ease with which the sulphur trioxide is eliminated from the gas.

The typhoid germs are perhaps killed somewhat more easily by the Clayton gas than by pure sulphur dioxide diluted with air. With the Clayton gas cultures survived respectively—

	4¼	hours at 8	per cent.
	2½	„ 7	„
and	2	„ 12	„

whereas with pure diluted sulphur dioxide they survived—

	3	hours at 10·5	per cent.,
	2	„ 5·5	„
	6	„ 1·9	„
	16	„ 0·5	„
and, to a limited extent,	7½	„ 10·5	„

On the whole there appears to be a slight but distinct superiority in the toxic power of the Clayton gas as regards typhoid germs, which I think is probably due to the fact that all material immersed in the gas becomes temporarily very damp. The cultures, as supplied by Dr. Eyre, had been very thoroughly dried, but if the dampness of the wrappings penetrated to the pellets of cotton-wool, etc., as it probably would, the action of the sulphur dioxide would undoubtedly be enhanced.

The sixth series of exposures was made with the direct object of elucidating this point, and at the same time of arriving at some idea of the lower limit of dilution.

The packages which had been exposed to the moist air felt damp throughout, as if they had been immersed in the Clayton gas, although they dried more quickly; but those which had been exposed to sulphur dioxide diluted with ordinary air felt quite dry. The increase in the toxicity of the gas in presence of moisture is very clearly shown by the results; typhoid germs are entirely destroyed in 16 hours, even by 0·5 per cent. gas, in presence of moisture sufficient nearly to saturate the diluting air, and a considerable proportion are destroyed in 6 hours by the same treatment. But when the diluting air only contains an average amount of moisture, typhoid is unaffected even by 16 hours' exposure to gas of this percentage.

As far as plague prevention is concerned, the difference, such as it is, is negligible. The cultures observed to survive the longest were, as a matter of fact, some of a batch exposed to the Clayton gas (Third Series); they were destroyed in 2 hours when the proportion of sulphur dioxide had risen to 14 per cent.

Taking the experiments as a whole, it seems that *the duration of the exposure is of much more importance than the percentage of sulphur dioxide*, and that it is quite unnecessary to aim at introducing a high percentage of this gas into the place undergoing disinfection. An exposure of 24 hours to a gas containing 2 per cent. of sulphur dioxide would give far more certain results than an exposure of say 4 hours to a 12 per cent. gas, and would

have the additional advantage that the sulphur dioxide by this dilution could be distributed over several times the space at the same cost.

It may be safely concluded that plague bacteria, and probably those of cholera, would be destroyed by 6 hours' exposure to a gas containing 2 per cent. of sulphur dioxide, but that the more resistant typhoid microbes would require from twice to four times this time. Anthrax spores would probably be unaffected in any case.

III.—The Time required for Complete Penetration of a Cargo.

The rapidity with which the experimental shed could be filled to the eaves with gas, taken in conjunction with the results described above, leaves no doubt as to the efficiency of the Clayton process for the disinfection of, and destruction of rats and insects in cabins, store-rooms, engine-rooms, empty holds, and other open spaces on shipboard. If the hold is charged with gas until the return pipe indicates 10 or 12 per cent.* as the Clayton Company recommends, and is then left closed for several hours, no rat can possibly escape destruction, and, with the exception of anthrax, the survival of bacteria is so improbable that it need not be considered.

When, however, the hold is filled with a densely-packed mass of cargo, such as bales or sacks tightly wedged together, this conclusion is no longer valid. In spite of the apparently good circulation of the gas over the upper surface of the cargo, and down the spaces between the cargo and the ship's sides, it is evident, from Dr. Haldane's observations (Part I. of this Report) that there must be places in the hold or cargo in which the proportion of sulphur dioxide never reaches the very small amount fatal to rodents and insects. The bactericidal properties of a gas in which rats can live are probably negligible.

If sulphur dioxide is absorbed to any extent by articles of cargo, the existence of such localities and the consequent escape of a certain number of rats and insects would be explained. A fact which points strongly to such absorption is that in practice it is found unnecessary to expel the gas by driving in air after fumigation.

(a.) *The Absorption of Sulphur Dioxide by Various Substances.*

As a preliminary measure I made a number of experiments on the extent to which pure sulphur dioxide is absorbed by ordinary

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* The burette provided by the Clayton Company for making a rapid estimation of the percentage of sulphur dioxide gives results from 1 to 2 per cent. too high. If a deduction of 1½ per cent. be made its readings are sufficiently accurate for *practical purposes*.

textile and food materials. The material under observation was placed in a flask connected with a mercury pressure-gauge, and the air in the flask was then replaced by sulphur dioxide.

Most substances absorb the gas, some very rapidly and in large amount, others comparatively little and slowly. The extreme cases appear to be wool and cotton. Cotton has not the least absorbent action on the gas, whilst wool absorbs it to a remarkable extent, slowly when the wool has previously been dried at steam heat, and very quickly when the ordinary amount of hygroscopic moisture is present. If a flask filled with sulphur dioxide be packed quickly with wool yarn, and then inverted in a vessel of mercury, the absorption is so rapid that the mercury will rise in the course of half an hour half way into the flask, which may be refilled with the gas four or five times before absorption ceases.

Other textile fibres such as jute absorb sulphur dioxide with moderate rapidity, but not to the same extent as wool. Ordinary grain, such as wheat and barley, absorbs to about the same extent as jute. Flour also absorbs the gas fairly readily, as do tea, ground coffee, cocoa powder, and the like.

The absorbed sulphur dioxide is very loosely combined. It disappears rapidly from wool merely on exposure to air, and most of the gas is given up when the wool is introduced into a vacuum. It is difficult to arrive at exact figures in the case of fibres; a bale of compressed wool would absorb at least 10 times its own volume of the undiluted gas, probably two or three times as much.

Flour and similar powders do not give up the gas nearly as readily, especially when at all moist. Wheaten flour containing the ordinary amount of moisture taken up from the atmosphere, holds when saturated 1·2 per cent. of sulphur dioxide by weight, or about 4½ times its volume of the undiluted gas.

The disappearance of the sulphur dioxide from a loaded hold after treatment by the Clayton process is thus explained. If the gas is absorbed by the cargo to even a fraction of the extent indicated by the laboratory experiments, its penetration into the remoter parts of a loaded hold must require a very long time. In order to gain some idea of the time which would be required in practice, I examined the gases drawn from the interior of bales of fibre while actually exposed to the Clayton gas.

(b.) *The Rate of Penetration of Clayton Gas into Bales of Fibre.*

The materials selected were jute and wool, as having moderate and great absorbtive powers respectively. The experiments with wool were made by desire of the Clayton Company, whom I have to thank for the loan of the bale. I selected the jute from a large stock by courtesy of Messrs. W. F. Malcolm & Co., wholesale merchants of London. The bales were treated just as imported, without removing the binding bands of the jute or the canvas covering of the wool.

The gases in the interior of the bale were drawn off through a slender steel tube of 1·5 mm. bore, which was provided with a sharp point of hardened steel so that it could be forced into the bale. The bore terminated in a channel transverse to the point, and at a short distance from it, so that the tube should not be choked during insertion. I found it practically impossible to purchase a tube of this description, and finally obtained it by the courtesy of Mr. J. B. Evans, the Chief Engineer to the Clayton Company, who not only suggested a method of construction in screwed sections, but was good enough to construct the instrument at his own lathe.

The bale was placed on end with the end of the steel tube opposite one of the portholes of the shed, through the wooden cover of which a glass tube of the same bore passed, connected hermetically with the steel tube. A gas sampler was connected through a three-way tap with the protruding end of the glass tube, so that the tubes could be washed out with the gas before each sample was taken for analysis.

1. *Experiments on Jute.*—The bale measured 30 × 20 × 20 inches, its cubic content being therefore about 11·5 cubic feet, or 327 litres. Calculating from the absorption experiments, this bale would require at least 45 cubic feet of undiluted sulphur dioxide or 450 cubic feet of 10 per cent. Clayton gas for complete saturation. The total quantity of gas drawn off for analysis did not exceed 0·5 litre in any one set of experiments, so that the error introduced by drawing external gases into the bale was negligible.

(1.) The bale was exposed for 3½ hours to a gas containing from 10 to 15 per cent. of sulphur dioxide.

The gas drawn from the interior of the bale before the experiment was commenced proved to be ordinary air. As soon as the shed began to fill with the sulphurous gas, the percentage of oxygen in the bale gas began to diminish, and that of nitrogen to increase, but no trace of sulphur dioxide was found. Next day after the shed had been aired, the gas in the bale was again normal air. The analyses are appended.

—	I. Before Experiment.	II. After 2 hours' Exposure.	III. After 3½ hours' Exposure.	IV. Next day.
Nitrogen	79·14	92·86	91·39	79·12
Oxygen	20·84	7·12	8·69	20·85
Carbon Dioxide	·02	·02	·02	·03
Sulphur dioxide	Nil.	Nil.	Nil.	Nil.

The composition of the gas in the shed at the times the samples were taken from the bale was as follows (neglecting carbon dioxide) :—

—	II.	III.
Nitrogen	79·9	80·0
Oxygen	6·6	7·8
Sulphur dioxide ...	13·5	12·5

After removing the sulphur dioxide, the residual gases had the composition :—

—	II.	III.
Nitrogen	92·4	91·4
Oxygen...	7·6	8·6

The close agreement between the percentage of oxygen in the gas drawn from the bale, and the percentage in the surrounding atmosphere of Clayton gas after removing the sulphur dioxide, indicates that the bale is quickly penetrated by the surrounding atmosphere, but that the sulphur dioxide is absorbed by the jute. This conclusion was entirely borne out by a second experiment.

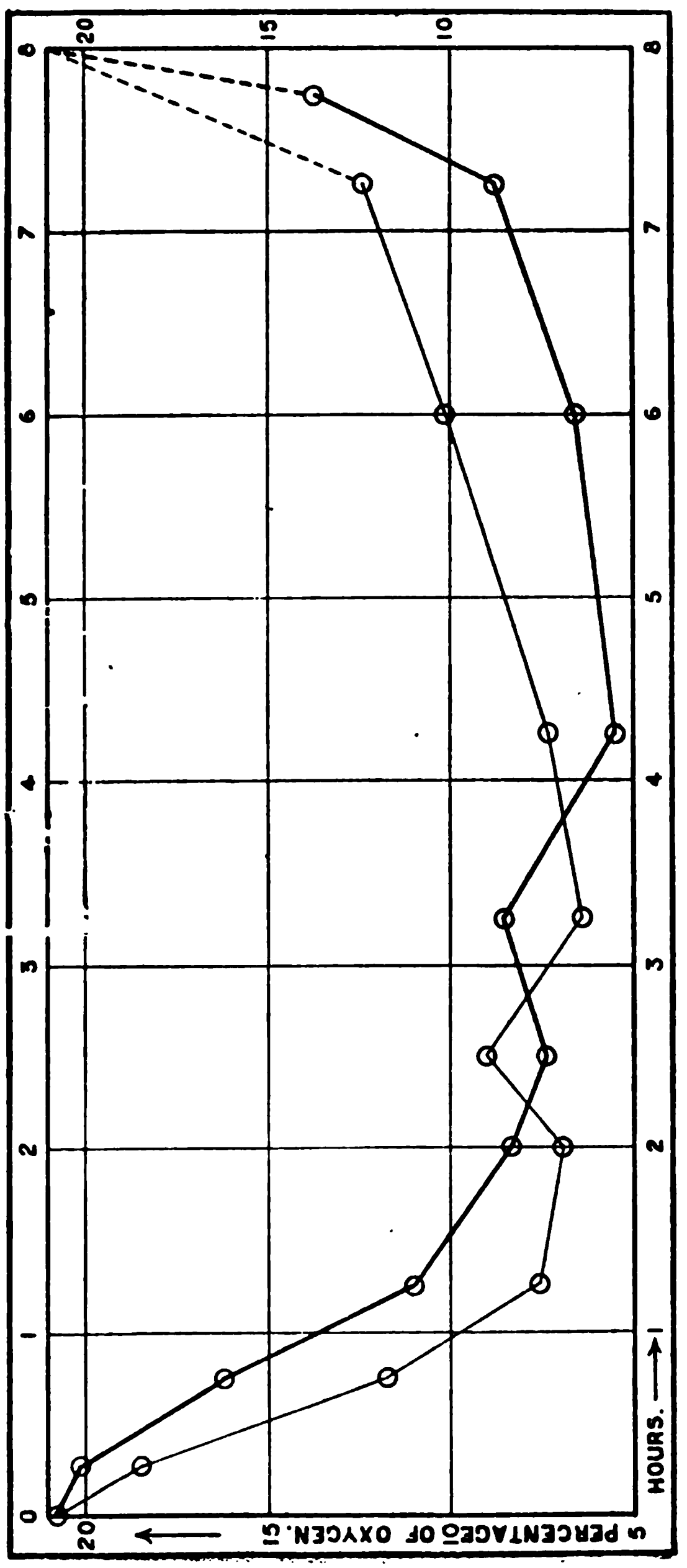
(2.) The bale was exposed for 8 hours to a gas of fluctuating composition. The percentage of oxygen in the bale gas fluctuated with the percentage in the surrounding atmosphere after removal of the sulphur dioxide, but at an interval of from 30 minutes to an hour. This is very clearly seen when the respective percentages are plotted in curves against time.

App. B, No. 2.

Destruction of Bale and Disinfection on Shipboard, by Drs. Haldane and Wade.

Time in Hours.

—	0.	1.	2.	1½.	2.	2½.	3½.	4½.	6.	7½.	7½.	24.
Clayton Gas in Shed.												
Nitrogen ..	79·1	79·5	79·9	80·9	80·9	80·1	80·5	80·8	80·6	80·1	passed	79·1
Oxygen	20·9	18·0	10·6	6·5	6·1	7·9	5·5	6·3	9·2	11·4		20·9
Sulphur dioxide	Nil.	2·5	9·5	13·6	13·0	12·0	15·0	13·5	10·0	8·5		Nil.
Clayton Gas after removing Sulphur Dioxide.												
Nitrogen ..	79·1	81·9	88·3	89·4	91·1	91·0	90·0	92·7	89·8	89·6	shed	79·1
Oxygen	20·9	18·5	11·7	7·0	7·0	8·0	6·4	7·3	10·2	12·4		20·9
Gas from Bale.												
Nitrogen ..	79·1	79·8	89·6	88·9	91·6	92·4	91·3	94·4	93·2	90·8	85·9	79
Oxygen	20·9	20·1	16·3	11·0	8·3	7·4	8·0	5·5	6·6	8·9	13·8	20·9
Carbon dioxide	0·02	0·1	0·1	0·1	0·1	0·2	0·1	0·1	0·2	0·3	0·3	0·02
Sulphur dioxide	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.



PERCENTAGE OF OXYGEN IN GAS FROM BALE.

" " " " CLAYTON GAS AFTER REMOVING SULPHUR DIOXIDE.

" " " "

t variation in the amount of carbon dioxide in the gas from the bale is a real one, and is due at the outset, as already mentioned, to the combustion of the methylated spirit used to ignite the sulphur. The subsequent variations are probably accounted for by the presence of foreign organic matter in the charges of sulphur; scraps of wood and other carbonaceous matter were often present. Sulphur dioxide could not be found by the most delicate tests.

In both these experiments the point of the steel tube was driven as nearly as possible to the centre of the bale, which stood on end. As the shortest edge of the bale was 18 inches long, the shortest distance from the inlet of the tube to the exterior of the bale was about 9 inches. The jute had been powerfully compressed, – dense, so that circulation through ch out of the question. The gas probal simple diffusion, just as it would pene as earthenware.

Although gases thus diffuse in and out of the bale with relatively great rapidity, the sulphur dioxide is absorbed so fast, that no trace of the gas penetrates to the centre of the bale in the course of 8 hours.

(3.) In a third experiment, the point of the tube was placed 2¾ inches from the surface of the bale. The jute was so hard and dense that there was no possibility of leakage along the outside of the tube. After the first hour the proportion of sulphur dioxide in the shed was maintained between 12 and 13 per cent., the gas after removal of the sulphur dioxide containing between 7 and 8 per cent. of oxygen. A sample of gas drawn from the bale after 1½ hours contained 6·8 per cent. of oxygen, and no sulphur dioxide.

A second sample taken after 6 hours from the start contained 8·3 per cent. of oxygen, and 1·5 per cent. of sulphur dioxide. The composition of the gas in the shed had remained steady at about 13 per cent. for two hours previously.

The sulphur dioxide thus penetrates in small quantity about one-third of the way into the bale in the course of 6 hours.

2. *Experiments on Wool.*—The bale employed was covered with canvas. It measured 28 × 35 × 29 inches, its cubic content being therefore about 16·5 cubic feet. The steel tube was immersed to a depth of 10 inches. From the absorption experiments the bale would require, for complete saturation, at least 165 cubic feet of undiluted sulphur dioxide, or 1,650 cubic feet of 10 per cent. Clayton gas.

The gas inside the bale on starting was ordinary air. After 50 minutes the sulphur dioxide in the surrounding gas was at about 11 per cent., and the oxygen after removal of the sulphur dioxide about 9 per cent. The oxygen in the bale gas was then 17·1 per cent., corresponding with the amount present in the surrounding gas about half-an-hour previously. At 3 hours from the start, the external gas having for some time averaged about

13 per cent. of sulphur dioxide, and 6·5 per cent. of oxygen after removing the sulphur dioxide, the internal gas contained 6·3 per cent. of oxygen. At 5¾ hours the percentage of sulphur dioxide in the external gas had risen slightly, whilst that of oxygen had fallen; the bale gas then contained 6·0 per cent. of oxygen.

In none of the samples was the slightest trace of sulphur dioxide present. The results being substantially the same as with the jute, the investigation was not carried further.

3. *Experiments on Cotton.*—I had no opportunity of carrying out similar experiments with cotton in bale, but from the results of laboratory experiments made on a smaller scale it is probable that sulphur dioxide would penetrate rapidly to the centre of a bale of cotton. As I have already stated, cotton has no absorbent action on sulphur dioxide, and if a mixture of the gas with air be forced through a long tube packed with cotton fibre, sulphur dioxide appears at once in the issuing air; with jute, and most of all with wool, there is much delay in the appearance of the gas.

These results render it clear that with the exception of cotton the disinfection of material in bale cannot be effected by means of sulphur dioxide. They further throw grave doubt on the possibility of distributing throughout a loaded hold a percentage of sulphur dioxide sufficient to kill every rat.

The bales in the hold are very closely packed, and there is no doubt, from the above experiments, that gases will penetrate with great rapidity throughout the mass, especially if, as is probable, numerous narrow channels exist between the bales. But it is equally clear that in the great majority of cases the sulphur dioxide will be absorbed in the course of this diffusion, and that animals taking refuge in the interstices between the bales and sacks will escape its action.

On the other hand, if the air in the hold could be replaced by Clayton gas containing a sufficient percentage of sulphur dioxide, and therefore a sufficient deficiency of oxygen, rats and mice would be asphyxiated from lack of oxygen, although insects would still escape.

It is very doubtful, however, whether the percentage of oxygen can be reduced to the necessary extent. The lowest percentage I found in gas from a bale was 5·5 (p. 352). This might suffice to asphyxiate some animals, but many would survive, and to ensure their complete extermination the oxygen would have to be reduced to 4 per cent., which there is reason to believe is impossible under the conditions.

App. B, No. 2.

It is probable therefore that with ordinary cargoes, excepting cotton, rats in loaded holds will not be completely exterminated by any sulphur dioxide process in a reasonable time, unless some such modification is adopted as the addition of carbonic oxide suggested in Part III. of this Report. In any case insects and bacteria will not be affected, except in those places to which the sulphur dioxide has free access.

IV.—The Question of Damage.

During the above investigations opportunity was taken to expose many samples of materials and foodstuffs to the action of the gas. Some of the specimens were exposed directly, some were covered with paper or placed in cotton bags, whilst others were made up into packages and bundles. The specimens may be conveniently classified as follows:—

Textile materials, fabrics, furniture, &c.
Metals.
Seed and grain.
Foodstuffs and the like.

(a.) *Textile Materials, Fabrics, &c.*

Materials and fabrics directly exposed to the Clayton gas invariably become very damp, and even when wrapped up the dampness is often very noticeable. Fabrics exposed *in a horizontal position* to the direct action of the gas retain this dampness, and are found to contain comparatively large quantities of free sulphuric acid, which may alter or destroy the colour, or even cause the disintegration of the fabric.

When, however, the fabric is suspended in a vertical position, or if horizontal, is covered with a single layer of the thinnest tissue paper, it suffers little or no damage; the dampness and odour of sulphur dioxide disappear rapidly on airing; sulphuric acid is absent, and the colour in the great majority of cases is unaffected.

The damage done to textile goods directly exposed to the fumes is, except in a small minority of cases, entirely due to the action of sulphuric acid. Sulphur dioxide has no permanent effect on fabrics unless they are deliberately wetted before or immediately after exposure, and with goods containing the normal amount of hygroscopic moisture even the slight temporary action is scarcely noticeable.

It should be stated that owing to the leakiness of the experimental shed the gas had to be pumped in steadily during the greater part of each exposure, and the amount of sulphur trioxide deposited on the unprotected materials in these experiments was therefore several times greater than would occur in practice.

The fabrics exposed may be classified as under :—

WOOL.

Plush (upholstery) :—
Maroon.
Green.

Cloth :—
Crimson.
Dark green.
Medium blue.
Violet.

Flannel :—
Scarlet.
White.

Blanket :—
Various colours.

Tapestry :—
Turkey red.
Bright green.

Spun yarn :—
Grey.

SILK.

India silk, thin :—
Scarlet.
Dark blue.

French silk, thick :—
Dark blue.

Satin :—
Pale blue.

WOOL AND COTTON.

Beige :—
Strawberry.
Sage green.
Lilac.

COTTON.

Calico prints :—
Scarlet and yellow.
Pink.

COTTON—*cont.*

Calico prints—cont.
Blue.
Lilac.

Sateen :—
Dark red (Congo).
Pink.
Yellow.
Pale blue.
Lilac.

Velveteen :—
Pink.
Pale Blue.
Medium blue.

Cretonne :—
Grey-green and pink.
Green, brown, and yellow.
Turkey red.
Green.

The samples were exposed—

(*a.*) Horizontally on tables 3½ feet from the floor.

(*b.*) The same, but covered with a sheet of thin tissue paper.

(*c.*) Hung on lines about 7 feet from the ground.

(*d.*) Made into a bundle, wrapped in a blanket.

The bundle was exposed on several occasions, altogether for 20 hours. The blanket in which it was wrapped became very damp and contained a considerable amount of free sulphuric acid. When opened after each exposure the contents smelled strongly of sulphur dioxide, but lost the smell quickly on airing, as also the slight dampness. The odour was simply that of sulphur dioxide, and not unpleasant when dilute. Some ladies to whom I submitted the samples compared the odour to that of "aromatic vinegar." I have on no occasion observed any unpleasant odour (other than the pungent odour of the sulphur dioxide). Even when the fabrics were permanently damaged by sulphuric acid there was no residual smell. The peculiarly persistent odour observed by Dr. Haldane after the disinfection of the *Bavaria* by the Clayton process (Part I. of this report) was evidently quite exceptional, and was probably due to the presence of a small quantity of selenium in the sulphur. A selenium compound which is formed when selenium is burned in air has a characteristic odour not unlike that of putrefying rats; this odour was recognised by Dr. Haldane as very similar to that which was observed on the *Bavaria*. I was unable to obtain a specimen of the sulphur used on that occasion, nor any information as to its source. Sulphur recovered from alkali waste, and thus derived ultimately from pyrites, may well contain traces of selenium.

The only fabrics showing any change in colour when placed side by side with untreated specimens were the wool tapestries, the wool yarn, and the coloured prints. The bright green tapestry was distinctly yellower in shade, that is, was slightly bleached. The turkey red tapestry had changed to a somewhat browner hue. The grey wool yarn was distinctly brighter in appearance, and bluer in shade. The white background of the calico prints had become slightly yellowish, causing the printed colours to appear somewhat duller; the colours themselves were unchanged. The changes however were very slight, and were only detected by direct comparison with the originals.

The fabrics which had been exposed to the direct action of the gas were exceedingly damp, and wherever the surface had been exposed horizontally were very acid with sulphuric acid. They did not dry when aired, but remained clammy for days, and were gradually rotted by the acid. The colours were generally speaking paler and duller, although many of the more delicate colours which would be expected to be the most susceptible remained unaffected. The most marked change was that of the dark Congo-red sateen, which, as is usual with dyes of this class, was turned dark blue by the free sulphuric acid. Sulphur dioxide had no action on this colour.

The scarlet silk was blackened and destroyed, and most of the fabrics were slowly disintegrated and rendered rotten wherever the sulphur trioxide had fallen.

The fabrics hung on the line were much damper than those wrapped in the blanket, but were only damaged in those places on which the sulphur trioxide could settle. A piece of the Congo red sateen which had been thrown across the line showed a dark blue strip at the fold.

Some garments were hung in the shed on one occasion, while others were packed loosely in the steel trunk already mentioned in connection with bacteriological experiments. Where exposed to the shower of sulphur trioxide particles or mist they were for the most part damaged. A grey tweed coat was stained red on the collar and shoulders, and in patches down the back, and parts of the lining which happened to face upwards were also affected. Some grey flannel trousers were also stained bright red in patches, and a dyed black sheepskin rug was similarly damaged, the tips of wool being stained red. The black canvas backing was also stained in patches, but the leather under the backing was not affected.

On the other hand a knitted blue jersey, although very damp and acid, remained unchanged: it was probably dyed with indigo the colour of which is not affected by sulphuric acid. A lady's coat of red cloth and dressing-gown of striped red and pink flannelette were unaffected, as was the black cloth skirt of a lady's dress.

The clothes packed in the trunk were unaffected except around the edges near the sides of the trunk. They had been packed loosely, leaving numerous narrow channels down the sides,

and in such places red patches frequently occurred. The heavy gas had evidently passed through the opening between the body of the trunk and the somewhat badly fitting lid, and had descended the channels with sufficient rapidity to carry in the sulphur trioxide mist. The clothes felt damp throughout, and took two or three days to dry. There was no unpleasant odour at any time.

Various other articles, such as gloves, books, brushes, &c., placed in the trunk were unaffected. The books smelled throughout of sulphur dioxide, but lost this after airing for a day or so. The paintwork of the steel trunk was unaffected.

Making due allowance for the excessive amount of sulphur trioxide necessitated by the conditions of the experiments, it is obvious that textile fabrics cannot be exposed to the direct action of the Clayton gas without considerable risk of damage. Even when on one or two occasions the exposure was cut short, and the amount of sulphur trioxide was comparable with that which would occur in practice, a considerable amount of sulphuric acid was still deposited, which, although insufficient to stain the cloth, caused it to become rotten in course of time.

When, however, the fabrics were protected from the sulphur trioxide merely by a single thickness of tissue paper, they escaped without damage (except occasionally such slight changes of colour as I have mentioned in connection with the bundle). This result appeared at first so remarkable that I repeated the experiment under various conditions. Sometimes the fabric was completely enclosed in the paper, sometimes it was merely covered loosely, and on other occasions part was covered while part was left exposed. I have no doubt that all damage can be obviated by this simple precaution.

The presence of sulphuric acid was proved in all the cases mentioned. On the occasion when the garments were stained red, I spread some sheets of tissue paper on a table and afterwards examined them quantitatively. The only acid present after airing was sulphuric acid, and this was in the free state. After 5 hour's exposure to the gas under these conditions the paper contained 1·0 to 3·4 milligrams of pure sulphuric acid per square centimetre, or roughly from one-third of an ounce to one ounce per square yard.

It may be concluded that, with reasonable precautions, no sensible damage need be done to the upholstery, cabin fittings and passenger's luggage during fumigation by the Clayton process. As I have already pointed out, it is doubtful whether fabrics in large bales, packed loosely in a hold, can be saturated with sulphur dioxide; but the damage to dyed and printed goods would be negligible even in the case of complete saturation.

(b.) *Metals.*

Various metals were exposed from time to time with substantially the same results as with the fabrics. With the exception of

pure gold leaf and platinum, all metals are badly tarnished where damped by the sulphuric acid. Even standard gold is blackened. But if the metal be protected from the sulphur trioxide, either by two layers of tissue paper (one is insufficient, as the damp paper may come directly in contact with the metal), or by smearing with a paste of ground chalk (whitening), the tarnishing is negligible.

The metals were mainly cut from thin sheet, and well polished before exposure. The following were exposed :—

Aluminium.	Lead and pewter.
Aluminium bronze.	Nickel and German silver.
Copper, bronze, and brass.	Platinum.
Gold, pure and standard.	Tin.
Iron and steel.	Zinc.

Various other observations were made incidentally in the course of the investigation. The painted steel trunk previously mentioned was old, and the metal was exposed in various places; it simply blackened, and did not rust. The brass lock was tarnished where the lacquer had worn off, but only slightly, its surface being vertical. White metal buttons were blackened where direct contact with sulphur trioxide was possible, but were left quite untarnished when protected by the cloth; in one case the projecting half of the button was blackened, whilst the hidden half was still bright.

(c.) *Seeds and Grain.*

Various seeds and grain were exposed in cotton bags in quantities of about 2 lbs. to the action of the Clayton gas. The time of exposure varied from 4 to 7 hours under the conditions previously detailed. As already stated, most seeds and grain absorb the gas slowly, but the gas absorbed does not appear to have any immediate deleterious action; barley, for example, germinated satisfactorily after a 5 hours' exposure. Eventually, however, the sulphur dioxide kills the germ, for the same barley four months later entirely failed to germinate, although under the same conditions an untreated sample of the original grain still germinated freely. The only other change observed was in rape-seed, the colour of which changed from gray to reddish-brown.

The samples treated included :—

Wheat.	Rape-seed.
Barley.	Linseed.
Oats.	Cotton-seed.
Maize.	Poppy-seed.

(d.) *Foodstuffs.*

The examination of foodstuffs after exposure to the Clayton gas confirmed the experience detailed in Section III. as to the absorption of sulphur dioxide. The odour of the gas often

persists for days, and even after it has disappeared, there is often enough left in edibles, probably in combination, to impart a distinct and somewhat unpleasant flavour.

Powdered substances, as a rule, retain the gas very persistently. The flavour of cocoa powder appears to be permanently impaired; the powder gave up sulphur dioxide when shaken with water even after 2 months' airing. Ground coffee is also deteriorated. The aroma of tea is diminished, and the characteristic odour of flour in time disappears. The Clayton Company placed before me samples of tea and flour, two of which had been exposed to the gas 12 months before, whilst the other two were untreated duplicates. I had little difficulty in distinguishing between them. On the other hand, I could detect no difference in odour or flavour between similar samples of Demerara sugar; but there was a distinct bleaching.

Refined sugar and common salt are unaffected. Whole coffee and cocoa-nibs are not changed, nor are whole pepper, cloves, rice, sago, tapioca, and almonds. Hard biscuits are quite unaffected, but soft biscuits and bread are spoiled; they have the unpleasant after-taste of sulphur dioxide, which is readily extracted from them, in the form of an alkali bisulphite, when they are shaken with water. Oatmeal also retains the gas persistently.

The most notable result was obtained with the treated flour. Fine wheaten flour was exposed in cotton bags to 14 per cent. Clayton gas for 5 hours, and the bags were then hung in a well-ventilated room for a week. At the end of this time the flavour of sulphur dioxide was still very distinct, although the odour could no longer be distinguished. The flour, and also its aqueous extract, gave an abundant reaction for sulphurous acid. I was informed that the residual gas could be removed by sifting the flour and transferring it to another bag. It was therefore sifted twice through a fine wire sieve, each time allowing it to fall from a height, so that the particles might be thoroughly exposed to the air. The flour was improved in taste, but still gave an abundant reaction for sulphur dioxide, of which it now contained 0·03 per cent. by weight, or about one-eleventh of its volume.

The two samples and control were made into loaves. The baker reported that the dough made from the first sample failed completely to "rise," whilst that made from the other rose only to a slight extent. The yeast was evidently sterilised by the sulphur dioxide. The loaves were heavy and uneatable, the interior being leaden in appearance, and scarcely to be cut with a knife. In both cases there was a strong and unpleasant flavour of sulphites, the presence of which was further confirmed by chemical tests. It was proved that the sulphur dioxide was in combination as an alkali bisulphite, and thus in a very stable condition. The loaf made at the same time from the untreated flour was light and palatable.

It is obvious that flour which has been saturated with sulphur dioxide is useless for bread-making. But by reason of the comparatively high absorptive power of the flour, prolonged treatment would be absolutely necessary if the gas is to penetrate

Ch. 8, Sec. 2. — Action of sulphur dioxide on animal life.

a fever-cargo in sufficient strength to kill the rats and destroy the bacteria present.

Dried fruit, such as dates, figs, and raisins, absorbed the gas to a considerable extent; the resulting flavour was at first agreeably acid, but was followed by the usual objectionable after taste of sulphites. The syrup obtained on steeping these fruits with water contained a marked amount of sulphites. Dried "currants" on the other hand were not sensibly altered in flavour.

Ordinary fruit and vegetables were quite spoiled. Bananas were softened and converted internally into a glutinous mass, smelling strongly of sulphur dioxide. Oranges and lemons became quite rotten and unedible. Apples became soft and shrivelled, as if they had been baked. Black grapes were bleached to a yellowish colour. Potatoes, carrots, and turnips were distinctly soft and flabby, and smelled of the gas when cut; as with the bread, part of this was in combination as an alkali bisulphite, and remained even in the cooked vegetables, which were unedible.

Some beef and mutton, exposed in cotton bags for 5 hours, were turned grey to a depth of about a quarter of an inch, as if they had been immersed for a short time in a sulphite bath. The grey layer remained after cooking, and the meat was quite unedible, its taste, and that of the gravy running from it, being extremely acid and disagreeable.

Cut tobacco, cigars, and Virginia and Egyptian cigarettes were all distinctly bleached, and their aroma was permanently impaired. The smoke of the cigarettes was distinctly acrid, resembling that of inferior brands, but not such as to render them unsmokable. The tobacco and cigars were unsmokable after 3 days' airing, but had quite recovered a month later; their colour, however, was permanently lighter.

V.—SUMMARY.

The results of the enquiry into the processes of disinfection by sulphur dioxide may be summarised as under:—

(1.) All rats and mice in a ship would be destroyed in less than 2 hours by the uniform diffusion of 4·5 per cent. of sulphur dioxide. This condition is easily realised in the case of cabins and empty holds, but owing to the rapid absorption of sulphur dioxide by many articles of cargo cannot as a rule be realised in a loaded hold.

(2.) Pathogenic bacteria, such as those of plague and cholera, require a somewhat larger percentage of sulphur dioxide, but under the same conditions, and with the same limitations, plague germs would be destroyed in 6 hours or more by a gas containing 2 per cent. of sulphur dioxide. The typhoid bacillus is considerably more resistant than that of plague, but would certainly be killed in 24 hours under these conditions. Anthrax spores are not affected by sulphur dioxide.

(3.) Most articles of cargo absorb relatively large volumes of sulphur dioxide, which they give up again more or less readily when exposed to air. A bale of wool absorbs at least 10 times its volume of the undiluted gas, and a bale of jute about 4 times its volume, but a bale of cotton probably absorbs none at all. Flour absorbs about 4½ times its volume of undiluted sulphur dioxide, a small fraction of which it retains very tenaciously.

The non-poisonous constituents of "Clayton gas" (nitrogen and oxygen) penetrate with great rapidity into the interior of bales, but owing to absorption the sulphur dioxide does not penetrate in any reasonable time.

(4.) Dry textile fabrics are not as a rule appreciably affected by sulphur dioxide, but where exposed to the direct action of "Clayton gas" are injured by free sulphuric acid, formed from the sulphur trioxide; they may be completely shielded from the action of this acid by covering with paper.

Metals are not affected by dry sulphur dioxide, but are tarnished by the sulphuric acid of "Clayton gas"; the tarnishing is negligible if the metal is covered with paper or with a thin coat of whitening.

Most seeds and grain absorb sulphur dioxide to a considerable extent, but do not appear to be appreciably affected by it until after the lapse of some months.

Most dry food-stuffs absorb sulphur dioxide, especially when in a state of powder, and in many cases retain enough of the gas, in combination as a sulphite, to impair the flavour. The amount thus retained in flour is sufficient to sterilise yeast.

Moist food stuffs, such as fruit, vegetables, and meat, are uneatable after exposure to sulphur dioxide.

III.—DISCUSSION OF THE PROCESSES PROPOSED FOR DESTRUCTION OF RATS ON SHIPBOARD; BY DRS. HALDANE AND WADE.

It remains for us to discuss the conclusions to which our observations have led us with regard to processes for the destruction of rats on ships with cargoes on board. Besides the Clayton process several others have been used, and we propose to refer to them one by one, commencing with the Clayton process.

THE CLAYTON PROCESS.

For the treatment of a vessel's hold the Clayton method possesses very distinct advantages. In the first place the process of filling the hold with the gas can be carried out simply by gravitation. The gas must in time find its way to the bottom because it is heavier than air. Any hold can thus be treated,

whatever the construction or system of ventilation may be. In the second place the process is perfectly safe. There is not the slightest risk of fire or explosion, and the possibility of asphyxiating any one on board is, with ordinary care, very remote, as the gas is so unpleasant that any one exposed to it would at once become alarmed, and escape long before any dangerous effect was produced; and moreover the gas is visible. A third advantage is that the gas, unlike carbonic oxide, kills insects. A fourth is that, as shown in Dr. Wade's report, which on this point confirms and amplifies the results of other observers, the gas produced by the Clayton apparatus is a very efficient disinfectant, provided it penetrates.

The disadvantages of the process are: (1) That it causes serious damage to various articles of food, such as fruit, flour or meat, and slight damage to metal work, &c. (2) That it is absorbed to a considerable extent by articles of cargo, and therefore penetrates a mass of cargo very slowly. It is thus not nearly so rapid in its action in holds filled with cargo as in empty holds, cabins, &c. Whether it will with certainty kill all rats in a hold after a few hours of continuous treatment is still uncertain.

Burning of Sulphur on Shipboard.

The process of burning sulphur is not applicable to holds full of cargo but may be applied to cabins and empty holds. The proportion of sulphurous acid attainable in the air of a closed space by burning sulphur in it is only about 2 or 3 per cent., but this is shown by Dr. Wade's experiments to be amply sufficient to destroy all animals, and to produce a fairly satisfactory disinfecting action within a few hours. In a recent investigation, Drs. Klein, Houston, and Gordon* have also found that albuminous emulsions of cultures of the following organisms were killed in every case when dried on wood, cloth, paper, and linen, and left for 24 hours in a room in which sulphur had been burnt in the ordinary way; *Bacillus typhosus, diphtheriae, and pyocyaneus; Vibrio cholerae; Staphylococcus aureus.* Spores of anthrax and tubercle bacilli in sputum were only partially destroyed. As the bacillus of plague seems to be more easily killed by sulphurous acid than *Bacillus typhosus*, we may conclude that the burning of sulphur would, if properly conducted, disinfect cabins, holds, &c., infected with plague. At least 1½ lbs. of sulphur per 1,000 cubic feet of air space would be needed for each hold. On the other hand the process is tedious, and involves risk of fire.

Liquid Sulphurous Acid.

Liquid sulphurous acid can be employed for both full and empty holds. It is more expensive than sulphurous acid prepared directly by combustion of sulphur, but it will probably

* Annual Report for 1901 of the Medical Officer of Health for the County of London, Appendix III.

cause somewhat less damage than the Clayton gas or the burning of sulphur. To use it efficiently for cabins, holds, &c., precautions would be needed for properly diluting it and diffusing it in the air. In full holds it would be, like the gas from the Clayton apparatus, liable to absorption by the cargo. The cost of liquid sulphurous acid, sufficient to produce an average 2 per cent. mixture with air in the empty holds, &c., of a vessel the size of the *Bavaria* would probably be about £16, while sulphur sufficient to produce the same effect on combustion would cost about £5. The saving in time, trouble, and risk of fire would probably more than repay the greater cost of liquid sulphurous acid as compared with sulphur.

Carbonic Oxide.

The use of this gas was suggested some years ago by the Medical Officer of the Local Government Board, and was reported on by Dr. Haldane.* The use of carbonic oxide was independently investigated by Dr. Nocht† ; it is now in actual use for destroying rats on loaded vessels at Hamburg. The advantage of carbonic oxide is that it can be very cheaply and easily made, causes no damage to, and is not absorbed by, the cargo. On the other hand, it has several disadvantages :—(1) It has no disinfectant action, and no action on insects ; (2) as it has practically no smell it is dangerous to man unless used with strict precautions ; (3) it is capable, under certain conditions, of forming an explosive mixture with air ; (4) it is rather lighter than air, and thus does not pass downwards by gravitation, although it would probably be carried through a hold pretty rapidly by convection currents and diffusion.

Some of these drawbacks can be overcome. In the Hamburg apparatus producer gas is made in a suitable furnace burning coke, and by means of a proper supply of secondary air a sufficient proportion of the carbon monoxide in this gas is converted into carbon dioxide, with the result that the final product is a good deal heavier than air, and is incapable of forming an explosive mixture. This mixture is supplied undiluted and unpurified. Damage might be caused to metals and possibly other articles by the presence of a little sulphuretted hydrogen and smoke, but with many cargoes the purification might probably be dispensed with. In the apparatus described by Dr. Haldane the producer gas is first purified, and then diluted with air to far beyond the explosive limit. This latter apparatus has, however, never been tried on ships.

Carbonic Acid.

Carbonic acid has been successfully used for destroying rats on ships at Marseilles.‡ Its advantages are (1) that it causes no damage

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* *Reports of the Medical Officer to the Local Government Board* for 1900-01, and 1901-02.

† Nocht and Giemsa, *Arbeiten aus dem Kaiserlichen Gesundheitsamt*, Vol. XX., Part 1, 1903, and *Deutsche medizinische Wochenschrift*, 1904, No. 7.

‡ Jacques, *Revue d' hygiene*, February, 1903, also *Bulletin quarantenaire*, Alexandria, June 9, 1904.

to cargo; (2) that it is heavier than air, so that a ship's hold can easily be filled with it by gravitation; (3) that it is much less dangerous to men than carbon monoxide, since it causes panting and extinguishes lights before it is dangerous to life. Its disadvantages are (1) that a very large amount of it is needed to kill rats and mice, almost 30 per cent. being required, so that an enormous amount has to be used in treating a ship, and the expense is thus very heavy; (2) it is not a disinfectant, and cannot be relied on to kill insects. The gas is supplied from a large number of steel cyclinders of liquid carbon dioxide, which are stored on a barge provided with special arrangements for emptying the cylinders and conducting the gas into the holds, and for afterwards displacing the gas by air.

It is clear that the choice of any process for employment will depend to a considerable extent on the circumstances under which the process is to be employed. If all vessels from plague-infected ports, whether known to be infected or not, were to be treated,* the question of expense of materials and of the damage producible by the sulphur process would be a very serious one, and probably the carbonic oxide process would be preferable on the whole. A skilled staff of men, capable of handling carbonic oxide with safety to all on board could be provided without undue expense considering the probable frequency of the operation. In cases of known infection of vessels, the treatment with carbonic oxide would doubtless need to be followed by a separate disinfection process. The question of a certain amount of damage by the sulphur process on vessels actually infected with plague, of which there are likely to be very few, is of no great importance, particularly as disinfection will be needed in any case. In view of all the circumstances we think, therefore, that a sulphur dioxide process will be most generally useful.

Provided the necessary apparatus could be supplied and worked at a reasonable cost, the Clayton process, in instances where it is desired to destroy rats on board before discharge of cargo, would probably be more useful in large English ports than any of the others discussed. Nevertheless there still remains great doubt as to whether the gas will penetrate cargoes sufficiently rapidly to kill all the rats within a reasonable number of hours, and a corresponding doubt as to the disinfecting action of the gas in the interior of a hold full of cargo. The Dunkirk observations related above show that in any case each hold will require several hours treatment at least. Further experience can alone decide what duration of treatment is really necessary. Should it turn out to be the case that too long a time is needed it seems probable that

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* *Note by the Medical Officer.*—The experience of recent years goes to show that, if ordinary precautions be taken, the risk of introduction and spread of plague in European ports is small. Hence the application of measures of rat destruction to *all* vessels from plague infected ports cannot, in view of commercial and economic conditions, be regarded as justifiable procedure. Such a course, moreover, would be in violation of the International Sanitary Convention of Paris, 1903, to which Great Britain is a party. In this country, therefore, measures of rat destruction will, in all likelihood, seldom be resorted to save in the case of vessels on board which plague has occurred in the human being or in the rat.—W. H. P.

the difficulty might be partly overcome by adding a small proportion of carbonic oxide (say 10 per cent. of producer gas) to the gas used for holds. This could be easily effected: Dr. Wade's experiments indicate very clearly that such a gas as carbonic oxide will penetrate cargo very readily; and there would be very little risk of accidental poisoning by carbonic oxide if the latter were used in connection with sulphurous acid, and only in loaded holds. The diminished proportion of oxygen in the interior of a cargo treated by the Clayton process would greatly increase the poisonous action of the carbonic oxide on the rats, which could thus be destroyed with certainty, while at any rate a certain proportion of the cargo would also be disinfected.

An alternative to the Clayton process is afforded by the use of liquid sulphurous acid contained in cylinders. This method is, we think, worthy of further trial, a sufficient amount of the gas being used, and proper arrangements being made to secure its diffusion. The use of liquid sulphurous acid has evident advantages on the score of convenience, safety, and absence of heavy capital outlay, over other processes. Whether it can be used in such a way as to be effective in holds full of cargo is still doubtful; but there is no doubt that it would be excellent in empty spaces, and could be used at a moderate cost.

Another method would be to treat only the accessible spaces of a ship with sulphurous acid gas in some form before discharge of cargo: to unload the cargo with all practical precautions to prevent rats from escaping from the holds and getting on shore; and then to treat the empty holds with sulphurous acid, so as to destroy all rats and insects. This course, while ostensibly aiming at the ideal in less degree than do procedures applied before discharge of cargo, has the important administrative advantages of being practicable at every port, and of being especially suitable in the case of cargoes liable to damage by sulphurous acid; and it may well be that this plan will be found to give as satisfactory results as more ambitious methods not yet free from difficulty in their application nor from doubt as to their efficiency.

[illegible] Observations of [illegible]
[illegible], by Dr. [illegible].

[illegible] I have described two [illegible] which differed from the [illegible] and physiological properties. The differences [illegible] permanent characters. The [illegible] were isolated from two different [illegible].

[illegible] is very similar to [illegible] a more or less [illegible]. It [illegible] is at all [illegible] or less [illegible]. It [illegible] and more or less [illegible]. It [illegible] are very [illegible] to [illegible] [illegible].

[illegible] has presumably [illegible] [illegible] bacillus is [illegible] [illegible] [illegible] coccus-like, and [illegible] [illegible] [illegible]. Its growth [illegible] [illegible] inconspicuous. Its [illegible] [illegible] [illegible] less angular than [illegible] [illegible] pig's [illegible] [illegible] [illegible] artificial [illegible].

[illegible] has been obtained [illegible] [illegible], as the history [illegible] [illegible] have further [illegible] [illegible] these differences [illegible] [illegible] [illegible] from rats [illegible] [illegible] as bacilli [illegible] [illegible] of its morphological [illegible] [illegible] remained [illegible] [illegible]. Kitasato's [illegible] were more [illegible] than type [illegible] [illegible] had [illegible].

[illegible] [illegible] [illegible] [

several years, whereas type No. 2, the "rat" type, has quickly lost its virulence almost completely. Another important point of distinction between these types is the fact that whereas type No. 1 rapidly recovers full virulence by a renewed passage through the animal body, type No. 2 does not do so. If once type No. 2 be allowed to part with virulence by repeated subculture, passing it later on through the animal body does not refurnish it with its original degree of virulence.

In illustration of these statements I cite the following experiments :—

I mentioned in last year's report that my laboratory B. pestis, which in all respects was the typical B. pestis (type No. 1), had been derived from a human case of fatal plague which occurred in the London Docks in October, 1896. It is labelled in the Laboratory, "L.P.I." (London Plague No. 1). Until 1901, subcultures of this micro-organism—carried on as stock culture by transference in gelatine every 4–6 weeks—acted in all respects very virulently on guinea-pigs, rats, and mice. It had been tested on many occasions and found in this sense satisfactory. At the end of a somewhat prolonged interval between two occasions of subculture the bacillus was tested and was found to have decreased in virulence, as gauged by amount of dose requisite for producing rapidly a fatal issue. But there was no difficulty in restoring to it, by one or two passages through the rat, a virulence quite as high both for the guinea-pig and for the rat as it originally possessed.

A like observation was made as regards a strain of B. pestis which was originally derived from the bubo of a human case of fatal plague (January 31st, 1901) in a worker in a particular flour mill at Cardiff, as also from the spleen of a rat (February 5th, 1901) from the same Cardiff flour mill.* The stock cultures of B. pestis of the bubo of the man and those also of the spleen of the rat (in the laboratory they are marked "Cardiff" bubo and "Cardiff" rat respectively) have in the course of the last three years certainly somewhat decreased in virulence though not very conspicuously. But there is no difficulty whatever in restoring their former virulence for the guinea-pig and for the rat by passage of the microbes through the rat or the guinea-pig. As a matter of fact during the early part of 1904 a number of experiments made with renovated Cardiff B. pestis on rats show that thus dealt with it possesses an extremely virulent character; a trace of the culture inoculated cutaneously caused typical plague in the rat, fatal in between two and three days, sometimes even within 48 hours.

It is quite different, however, with the B. pestis of type No. 2, or "rat" type. The two strains of this type already referred to—viz.: the Edington rat strain and the strain L.P. II. of last year's report—have for more than nine months become quite useless as regards virulence. One half to a whole culture injected intraperitoneally into a guinea-pig or a rat does not cause death; a whole culture injected subcutaneously into the groin of a guinea-pig or rat causes tumour and suppuration of a temporary nature,

* *See* Dr. Bruce Low's Reports and Papers on Bubonic Plague (1902), p. 30.

but the animal appears always lively, feeds well, and does not die. So that at present both strains have become quite valueless, quâ B. pestis, from an experimental point of view.

It will no doubt be urged that the two types must have some intimate relation to one another; they are not different species but only varieties which have become more or less permanent in some of their characters. As was mentioned in last year's Report, they do not differ in most other respects, *e.g.*, in staining, in culture on agar, on serum, and in broth; and they both produce plague in rodents. Indeed I myself am assuming that type No. 2 has been bred so to speak by a series of passages through the rat. Under natural as also under experimental conditions, even when virulent plague material is in question, it does not always happen that every rat dies of the acute disease; in one or another rat, the disease takes sometimes a subacute or even chronic form. It is quite possible that this exceptional result is due to a greater resistance of one animal as compared with another to B. pestis of the same source: and similarly it is possible that by being bred in an animal of extra resistance B. pestis loses somewhat of its natural virulence, so that when transmitted to a rat of normal susceptibility it not only produces plague in a less acute form but continues further to lose virulence as it passes from rat to rat. I have experimental evidence that such a change does occur and that the changed bacillus may afterwards "breed true," thus:—

In last year's report I have pointed out that there exists a constant difference between the guinea-pig and the rat in the matter of *cutaneous* inoculation. If the guinea-pig is inoculated with plague material (bubo, spleen or the like), or with culture, into a *cutaneous* abrasion or *cutaneous* surface incision, the result, however virulent the plague material employed, is invariably plague in a subacute or in a chronic form; the animal dies of plague eventually but it does not die until towards the end of a week, two weeks, or even longer. The post-mortem appearances in such case are invariably these:—Necrotic bubo, necrotic nodules of the spleen, liver, and lung. But the same virulent material, as above, when inoculated *subcutaneously* into the guinea-pig, usually produces the acute disease with death in 2–4 days, and without the necrotic nodules of the spleen, liver, and lung.

In the rat on the other hand the acute disease is produced almost invariably with such material, no matter whether inoculated *cutaneously* or *subcutaneously*.

Now, it has occasionally happened that the necrotic material of the bubo of a cutaneously inoculated guinea-pig (*i.e.*, one dead from the subacute disease) when transferred *subcutaneously* to a fresh guinea-pig has caused the subacute form of the disease; and further it has happened that notwithstanding transmission of the plague material thus obtained in subcutaneous manner through an additional series of guinea-pigs, its virulence has not increased; on the contrary in some instances it has even diminished, so much

so that eventually only a local effect was produced: the animal remaining alive. Cultures, therefore of the bubo after attenuation has been thus reached are quite untrustworthy for producing fatal acute disease in the guinea-pig or the rat, however inoculated, *i.e.*, cutaneously or subcutaneously. Clearly then, occasions arise when the tendency to attenuation of virulence having once arisen, a phase of attenuation may be arrived at which is practically permanent. I do not say that this is invariably the case, but I have had to abandon particular plague material, as also cultures of it, altogether for the reason that it failed to produce fatal result. In other cases the virulence after passage through one or two animals was regained. Nevertheless I am satisfied that B. pestis of attenuated virulence appearing by chance as it were in a series of experiments *may* under some conditions breed true.

I propose to describe experiments which show that it is possible to "breed" in the rat an attenuation of B. pestis of a permanent character, presenting that is morphological and cultural peculiarities which are proper to the second or less virulent "rat" type of B. pestis.

On several occasions I have tested for the Board the efficacy of the Haffkine plague prophylactic. This was done on rats, for the reason that Professor Haffkine and I had ascertained that subcutaneous injection of 10 cc. of his prophylactic fluid is uniformly efficacious in protecting a full-grown rat against a subsequent injection of a large (multiple fatal) dose of virulent culture of B. pestis. The samples of prophylatic fluid tested comprised a batch prepared by Professor Haffkine in Bombay and a batch prepared by me in London.

A number (ten) of rats* were injected subcutaneously in the groin with plague prophylactic, 10 cc. per animal.

All these animals appeared on next and subsequent days lively and fed well; but all exhibited tumour in the groin. After three (weeks) during which time the animals remained quite well, the initial tumour having for some days completely disappeared, all of them were inoculated cutaneously with the tissue of the bubo of a rat that had died in three days of typical acute plague after inoculation with culture of L.P.I. The juice of this bubo was crammed with B. pestis. At the same time, and with the same material, one control rat was inoculated also cutaneously. This control rat died within three days with typical plague: but all the "protected" rats appeared lively and feeding well, and they remained so. At the end of the week these animals, being seemingly normal, were killed. On post-mortem examination all but two were found quite normal in every respect. All had perfectly normal viscera; but one rat had a small gland in the groin at the side on which the inoculation (cutaneous at root of tail) had been performed, and a second rat had a swollen gland in the groin, about the size of a filbert, also on the inoculated side.

*In all these experiments tame (white) rats were used, for reasons which were stated in my last year's Report, viz that white rats are highly susceptible to plague, are easier to be kept in cages, and easier also to handle.

An incision into the swollen gland, especially in the case of the second rat, showed the interior necrotic; film specimens made of the gland in both cases showed numerous particles representing bacilli in various stages of degeneration, from rods more or less granular to spherical small and large globules. Cultures on gelatine were made in both cases with relatively large amounts of the gland tissue, and in each instance a fair number of colonies of B. pestis was obtained. The number of B. pestis colonies was however incomparably smaller than that induced by a similar proceeding in an unprotected animal when a much smaller particle of a typical plague bubo is used. The colonies (on gelatine) did not on inspection with a glass present any noticeable difference from those of the typical B. pestis that had been initially employed (L.P.I.), except that during the first few days after their appearance they might be considered somewhat less granular and more translucent than usual. In film specimens examined under the microscope the bacilli appeared markedly short, certainly shorter than in a similar preparation of the typical L.P.I. The most striking characteristic of this culture and subsequent subcultures was, however, the fact that their virulence was decidedly of a lower degree than that of the B. pestis (L.P.I.) with which the series had been started.

The following experiments illustrate this :—

SERIES A.

Experiment 1.—A rat (*a*) was injected cutaneously with a three days' old gelatine culture of "L.P.I."

A second rat (*b*) was at the same time injected with a three days' old gelatine culture of the swollen gland of one of the Haffkine protected rats just referred to.

In both cases, therefore, the B. pestis was originally the same strain, viz. : L.P.I. ; but as just described the culture for rat (*b*) was derived from the gland of a protected rat.

Rat (*a*) died in less than three days : post mortem there was a big bubo on the inoculated side crowded with B. pestis ; the spleen was large, dark, full of B. pestis ; the intestine was inflamed, containing sanguineous mucus ; the heart's blood contained numerous B. pestis.

Rat (*b*) had a big bubo on the inoculated side. But it remained lively and fed well up to the seventh day, when it was killed. Post-mortem examination showed the inguinal glands much enlarged, and necrotic in their interior ; few bacilli noticeable. The viscera, including the spleen, appeared unaltered.

Experiment 2.—One rat, IA, was inoculated subcutaneously with (a large dose) two loops of a four days' old agar subculture (second transfer) of the swollen gland of the protected rat. This rat died on the fourth day. On post-mortem examination it showed : big bubo, crowded with short B. pestis ; spleen enlarged

and containing some (bipolar) B. pestis; intestine, liver, and lung showed no perceptible change. The heart's blood did not contain bacilli.

Experiment 3.—One rat, IB, was injected cutaneously with a fair dose (several drops being well rubbed into scarifications of the skin at the root of the tail) of sanguineous turbid juice (crowded with B. pestis) from the bubo of rat IA. This rat was found dead on the fourth day. Post-mortem: Hæmorrhagic inguinal bubo on the side corresponding to the site of the cutaneous inoculation. The juice of this bubo was crowded with short (bipolar) B. pestis. Spleen not enlarged, no bacilli; heart's blood no bacilli; other viscera showed no noticeable change. The culture of material from the bubo produced translucent growth on gelatine, the bacilli very short.

Experiment 4.—One rat, IC, was inoculated cutaneously with a good-sized loop of a subculture on agar of the above bubo of rat IB. The animal was found dead on the fourth day. The inguinal gland corresponding to the side of inoculation was found enlarged, and contained numerous short B. pestis; most of them in a state of degeneration (granular), some swollen up into spherical masses. The spleen was slightly enlarged and contained a fair number of B. pestis, showing bipolar staining. Heart's blood no bacilli.

From this series of experiments it appears that typical virulent B. pestis (L.P.I.) by passage through a Haffkine protected rat had distinctly become attenuated in virulence when employed, whether as bubo juice or as culture therefrom, in the inoculation of a succession of rats. Under ordinary conditions, be it remembered, the most virulent material available is the juice of the bubo of an animal (of the same species) dead of acute plague. Nevertheless in the experiments in question such material proved barren of a high degree of virulence, the chief manifestation of disease induced being a local bubo, with delay of fatal result. Furthermore, this attenuated B. pestis presented the morphological and cultural characters (conspicuous shortness of the bacilli in culture, transparency of growth on gelatine in the earlier phases) of the type of B. pestis which I have characterised as type 2.

SERIES B.

A considerable number of experiments was made with virulent B. pestis that had been obtained on January 31st, 1901, from the bubo of a man dead of plague who had worked in a plague infected flour mill in Cardiff. The subculture of this strain (as also of a rat—strain from the same flour mill) is at present—end of 1903 and beginning of 1904—of normal high virulence: a trace of a 48 hours' old growth on agar inoculated cutaneously into a rat causes (fatal within 72 hours) acute septicæmic plague of the typical character.

Experiment 5.—With a trace of a 48 hours' old agar growth of B. pestis from the Cardiff bubo, a rat was inoculated cutaneously

on left side of its tail-root. The animal was found dead in about 60–66 hours. Post-mortem examination showed the following condition : Scab on site of inoculation ; left inguinal glands much enlarged and deeply congested, in parts purple, hæmorrhagic ; spleen much enlarged, dark, firm ; intestines congested, relaxed and full of sanguineous mucus ; kidneys and liver much congested ; both lungs deeply congested. The juice of the swollen hæmorrhagic inguinal gland and the juice of the spleen were crowded with typical B. pestis. Droplets of heart's blood and of spleen juice gave rise to crowds of colonies of B. pestis in pure culture.

With a trace of the spleen juice of this rat another rat was inoculated cutaneously by way of superficial abrasions at the tail root. The animal was dead within 70 hours. Post mortem : right inguinal glands enlarged, hæmorrhagic ; spleen much enlarged, dark, firm ; kidneys and liver congested ; lungs congested and showing numerous punctiform hæmorrhages. Droplets of heart's blood and spleen juice yielded crowds of colonies of B. pestis in pure culture.

One further set of experiments with this strain of the Cardiff bubo B. pestis deserve to be mentioned.

Experiment 6.—With a trace of the growth of a 48 hours' old agar subculture (directly descended from the original culture), one rat (*a*) and two mice (*b*) and (*c*) were inoculated cutanequsly, each at the root of the tail.

One mouse (*b*) was found dead within 44 hours, the other mouse died within 60–65 hours. In both animals the result of post-mortem examination was the same : bubo in left groin crowded with B. pestis, the tissue surrounding it very oedematous ; spleen much enlarged, dark, firm and crowded with B. pestis ; lungs much congested ; liver pale ; kidneys, large, dark red. Heart's blood yielded copious growth of B. pestis.

The rat was found dead within 70 hours. Post-mortem appearances : big inguinal glands with hæmorrhage showing crowds of B. pestis ; spleen enlarged, dark, firm, and containing crowds of B. pestis ; kidney and liver large and much congested ; both lungs much congested. Heart's blood yielded crowds of colonies of B. pestis in pure culture.

It is clear from the above that this strain of B. pestis (Cardiff bubo) is of normal and high virulence ; and I may add that colonies of the microbe in their early phases of culture on gelatine were of the typical angular, granular "opaque" kind, and that the bacilli from them were of the typical cylindrical form. That is to say this strain is in respect of virulence and in all its morphological and cultural characters a good representative of the type No. 1 (human).

In contrast with the B. pestis (type No. 1) of experiments 5 and 6, I pass to further experiments with the attenuated B. pestis of the second or rat type, derived from the inguinal gland of the Haffkine protected rat already referred to earlier

in this report. B. pestis of this type is in culture shorter than that of type No. 1 and it forms in the earlier phases of its growth on gelatine less angular and more rounded colonies, the growth on the gelatine being at the same time more translucent and less granular. These characters have now become permanent through many subcultures. The difference between the two types here dealt with—viz.: the strain of Cardiff bubo (human type) and the strain of protected rat (rat type)—is so distinct that, on looking at streak as also stab cultures, or at plate cultures on gelatine of the two strains under exactly the same conditions, the distinction during the first three or four days cannot be missed. I have repeatedly asked colleagues to inspect with a glass a number of parallel cultures of the two strains and they invariably, and without difficulty, picked out and grouped quite correctly the cultures of the two strains.

The parallel experiments made with the strain from the protected rat (type No. 2) are these :—

Experiment 7.—A rat (rat 1K) was inoculated cutaneously with a trace of the growth of a two days' old agar subculture of the bubo of the rat 1B mentioned in series A (experiments with strain of B. pestis derived from protected rat). This rat was found dead on the seventh day. Post-mortem : the inguinal glands were found swollen and hæmorrhagic ; small intestine and lungs congested ; spleen not enlarged. The inguinal glands were crowded with B. pestis, which by culture was proved to be of the type No. 2. The heart's blood did not yield colonies of B. pestis. The culture was quite liquefied in 48 hours, owing to contamination.

The result of this experiment is, then, quite confirmatory of experiments mentioned in series A, viz., that B. pestis of type No. 2 does not cause the pathological changes typical of B. pestis type No. 1, its effects being chiefly bubo with crowds of B. pestis (type 2) in it.

Experiment 8.—A rat 1L was inoculated cutaneously with a two days' old agar subculture of material from the bubo of rat 1C of series A, which had itself been inoculated with a subculture of the bubo of rat 1B.

Rat 1L was found dead on the fifth day—it died in the night between the fourth and fifth day. The post-mortem examination showed the inguinal glands corresponding to the inoculated side swollen and hæmorrhagic ; small intestine relaxed, containing sanguineous mucus ; spleen enlarged ; upper lobe of right lung deeply congested. Inguinal glands and spleen contained abundance of B. pestis of type No. 2.

This, then, was a case of distinct septicæmic plague differing from the typical form (virulent type 1) only in the fact that death was delayed and that the colonies derived from both the bubo and spleen were of the same transparent variety as those of the B. pestis used for inoculation.

Experiment 9.—A further rat 1M was inoculated cutaneously with a fair amount of the (transparent) growth of a culture

from the spleen of rat 1L. This animal died on the fifth day. On post-mortem examination the inguinal glands of the inoculated side were found slightly enlarged, the spleen very slightly enlarged. Cultures of the spleen and heart's blood yielded no growth.

Experiment 10.—A further rat 1N was inoculated cutaneously with the growth of a two days' old agar subculture (second remove) of the same stock (spleen of rat 1L) as in the preceding experiment. This animal was distinctly ill on the third and fourth day; being quiet, not feeding, its coat slightly rough. The control rat inoculated on same day as 1N with culture of the same date (two days agar) of the Cardiff bubo type was found dead in 60–66 hours with severe plague. But rat 1N on the sixth day, though still ill, was alive. On the fifteenth day it was still not feeding well and had a slightly rough coat, but it was better in respect of moving about freely. The animal was now killed and showed the following appearances: no bubo; spleen not enlarged; ileum congested; Peyer's glands marked; liver normal; kidneys large, congested. No cultures were obtained from either the inguinal glands, the spleen, or the heart's blood.

This experiment shows conclusively the attenuated less virulent condition of the type 2, and contrasts strongly with the action of a parallel culture of the type 1. Be it remembered that rat 1N was inoculated with a subculture (second remove) from the spleen of a rat (1L) which rat had died of acute plague, caused by inoculation with the B. pestis of the second type.

It follows from these experiments that after passing through a succession of rats B. pestis of the type 2 retained its attenuated action unimpaired.

The above are not by any means the only experiments which I have made on rats with active cultures, 24 hours and 48 hours old agar cultures, of the (transparent) strain (type 2). Thus, I have records of rat 1O, 1P, 1Q, 1R.

Experiment 11.—Rat 1O was inoculated cutaneously with the growth of a 48 hours' agar subculture from rat 1L.

Experiment 12.—Rat 1P with 48 hours' culture from the spleen of a mouse dead within 48 hours after cutaneous inoculation with same strain (see later), cutaneously.

Experiment 13.—Rat 1Q with a 24 hours' old agar subculture from rat 1L, cutaneously.

Experiment 14.—Rat 1R with a 24 hours' old agar subculture (second remove) from spleen of rat 1Q, subcutaneously.

In all the cases where inoculation was practised cutaneously a fair-sized particle of the growth was well rubbed into several crossed incisions. In the case of rat 1R a large dose of culture was injected subcutaneously into the groin.

The subsequent history of these animals is as follows:—

Rat 1O died between fifth and sixth day.

Rat 1P, which appeared normal, was killed on the eighteenth day: completely negative result.

Rat 1Q, which died on the fourth day, showed post-mortem: swollen lymph glands, with hæmorrhage, in both inguinal regions; spleen large; lungs congested. Spleen, bubo, and heart's blood yielded crowds of colonies of B. pestis of the type 2.

Rat 1R died on the seventh day. As mentioned above, this rat had been injected subcutaneously. The post-mortem examination showed: Bubo in groin at injected side; spleen slightly enlarged; intestines congested. Cultures of the spleen brought forth a fair number of colonies of B. pestis (type 2); cultures of heart's blood yielded a small number of colonies of the same type, 2.

In all these instances there are seen therefore the same features not only as regards virulence and pathological result but also as regards the preservation of type 2.

Experiment 15.—This same type 2 of B. pestis (derived from rat 1L) was used for cutaneous inoculation of mice, and at the same time other mice were cutaneously inoculated with B. pestis of type 1 (Cardiff bubo), with result as follows:—

Two mice (1 and 2) were inoculated cutaneously at the root of the tail with a 48 hours' agar subculture from spleen of rat 1L.

Two mice (3 and 4) were cutaneously inoculated with 48 hours' agar subculture of the bacillus of Cardiff bubo.

Mouse 3 found dead in 40–44 hours.
Mouse 4 „ „ 60–66 „
Mouse 1 died in 48 hours.
Mouse 2 found dead in 60–66 hours.

The post-mortem examination was in all four animals the same: Swollen hæmorrhagic inguinal glands with surrounding œdema on the inoculated side; spleen large, dark, firm; liver pale; kidneys large, deep red. The inguinal lymph glands and the spleen contained crowds of B. pestis. The lymph glands were especially remarkable in this respect, and later a description will be given of sections made of these hardened glands.

But though the two sets of mice showed no difference as to virulence and pathology corresponding to the two types of B. pestis from which the infecting material was derived, the morphological and cultural distinctions between B. pestis of the two types were nevertheless maintained in the cultures obtained from their organs. Moreover, although mice 1 and 2 died as rapidly as mice 3 and 4 a culture from mouse 1 when tested on a rat (1P) proved of very little pathogenicity, as was described above, Experiment 12.

It might of course be contended that this attenuated action of the culture of the spleen of mouse 1 when inoculated into rat (1P) was due to the fact that possibly B. pestis having passed through the mouse had as a consequence become less virulent for an animal of a different species, to wit the rat; an opinion to this

effect has indeed been actually expressed by Calmette. I must confess that I was rather surprised at Calmette's statement, for I have not found any marked attenuation taking place of the really virulent B. pestis—*e.g.*, type 1,—when this is transferred from an animal such as the mouse dead of typical acute plague to an animal of a different species, *e.g.*, the rat or the guinea-pig. Experiments which I have made in this direction (and as to which I need not enter into details) with virulent B. pestis (Cardiff bubo) show that no such general rule obtains as is implied in Calmette's statement; that indeed general experience is to the contrary.

On the other hand, attenuation of B. pestis once having become as it were fixed, I have not been able to notably modify it. For instance, I have not found that, starting with attenuated B. pestis, passage of it through a succession of *guinea-pigs* causes any enhancement of its virulence.

As I have already pointed out, both last year and this, inoculation of a guinea-pig *cutaneously* with plague from whatever source (virulent or less virulent) results invariably in a subacute disease, fatal after 6, 7, and more days; the animal showing post-mortem necrotic bubo and small necrotic white nodules in the spleen, liver, and often also the lung. This is, as I have said, invariably the result of inoculating the animal by rubbing in the infective material into cutaneous abrasions or superficial incisions. Also I have shown that in the case of *subcutaneous* injection with ordinary small dose of virulent material the disease is fatal in from 48–72 hours, but without necrotic changes being found in the bubo, spleen, liver or lung. And further I have shown that in the case of attenuated virus (or of very small doses of more virulent material) even *subcutaneous* injection will cause the subacute disease with the above necrotic nodules in spleen, liver, and often lung.

Experiment 16.—Several experiments were this year made on successive guinea-pigs with the strain of B. pestis of type No. 2 (derived from the Haffkine protected rat). Always however this retained its initial attenuated or less virulent character even through a succession of six guinea-pigs. Every one of the animals died of the subacute disease (6–12 days) with the necrotic change in the bubo, necrotic nodules in the spleen, liver, and lung. These guinea-pigs had been inoculated, some cutaneously some subcutaneously, with considerable doses of the necrotic tissue of the bubo (teeming with B. pestis) of a preceding guinea-pig. The last of the series received subcutaneously in the groin a cubic-centimetre of a thick turbid emulsion of the necrotic bubo of the preceding guinea-pig; but, as before, the result was the subacute disease, showing necrotic bubo, and necrotic nodules in spleen, liver, and lung.

Experiment 17.—The following experiment demonstrates the same result from another point of view. As already mentioned, Mouse 1 (B. pestis, type No. 2) died in 48 hours from typical acute plague; the spleen was found large and crowded with B. pestis of type No. 2. With a good dose—about two loops in each instance—of recent agar culture of the spleen of this

mouse two other mice (5 and 6) were inoculated, the culture being well rubbed in into several crossed incisions of the skin at the roots of their tails.

One of these mice, No. 5, died on the fifth day, the other No. 6 died on the seventh day. Both on post-mortem examination showed big inguinal glands and big dark spleen. Bubo, spleen and heart's blood yielded numerous B. pestis of type 2.

There is distinct evidence then that the B. pestis taken from mouse 1 was also for mice (5 and 6) of a distinctly minor virulent character, since death ensued in one case on the fifth day in the other on the seventh. This is altogether different from what took place in the case of mice inoculated cutaneously with the B. pestis of the Cardiff bubo type (Experiment 15).

It is justifiable therefore to conclude that the B. pestis secured through the medium of the Haffkine protected rat is of a different type ("rat" type) to the B. pestis derived from the Cardiff bubo ("human" type), seeing that B. pestis in this phase maintained its particular and minor virulence, as also its morphological and cultural characters, unimpaired, however many times it was subcultured or was passed through the animal body. Further, there is in this year's experiments confirmation of last year's observations as to type No. 1 (or human type) being of a more virulent character than type No. 2 (rat type) in the fact that type No. 2 has been now derived from the swollen gland of a protected rat, a rat namely that had by previous injection with Plague prophylactic been furnished with a high degree of resistance.

A strain of B. pestis which possesses and which maintains in its passage through successive rats its attenuated virulence might obviously very well be bred in nature. If for instance in a ship sailing from an infected port plague brought on board by rats spread epidemically amongst the ship rats in the course of a long voyage, the most susceptible of these ship rats would of course be the first to die off; the last to remain would be those infected with the chronic form of plague, *i.e.*, with B. pestis which had passed through a series of rats less susceptible to the disease. As a result the B. pestis passed on from the remaining rats, after arrival of the vessel at her destination, to rats on shore would tend to be of no great consequence, for the reason that by the passage of a weakened strain of plague through a succession of rats the acquired attenuation of virulence would be likely to have become permanent. Further, plague of this sort communicated by the shore rats to the human community ashore would in all probability be little diffused and of a non-virulent type; so that only amongst the more highly susceptible inhabitants would there occur recognisable plague cases and deaths. It is probably that for some such reason many outbreaks of plague presumably originating in plague of rats in occidental countries have proved, both as to incidence and mortality, of a less severe type than in Oriental countries where the virulent or human type is the predominating character of the B. pestis, and where also rats are constantly being infected directly from human subject.

While this view of an attenuated type of plague bred in the rat appears indicated by these experiments, it does not necessarily follow that, when after its passage through a succession of human beings the B. pestis again enters the rat, virulence in the sense of type No. 1 will not again be restored to it, and with the result that, for a time at any rate, the virulent or human type of B. pestis might prevail among the local rats; until, indeed, by a succession of passages through the rat, attenuation of type was again brought about. Further observations on this point will need to be made.

That the rat is highly susceptible to plague, more susceptible than the human being, seems a generally accepted fact, and this would accord with the views above expressed, viz., that while the rat is fatally amenable to both types of plague, the human being is less susceptible to type No. 2 (the rat type) than to type No. 1 (the human type).

In last year's report I have described the pathological changes in guinea-pigs and rats which died of plague, and the distribution of the B. pestis within their bodies. I now supplement that description by noting more in detail the morbid appearances in rats and mice which succumb to plague, whether type No. 1 or type No. 2, *after cutaneous inoculation*, which was the method used in most, practically in all, of the experiments mentioned in this report.

Description of the Pathology of the Organs in Rats and Mice Infected with Plague.

In all instances the organs and tissues were hardened in Müller's fluid in the usual manner, and fine sections of them were stained in methylenblue and eosin, the former dye picking out (blue) nuclei and bacilli, the latter (red) the blood discs.

1. *Rats inoculated cutaneously with the virulent type of Plague.*

Rats thus dealt with—*i.e.*, inoculated with plague of London Port No. 1 and Cardiff Bubo type—exhibit, with very few exceptions, the following conditions :—

1. *The inguinal lymph glands.*—As already mentioned, cutaneous inoculation of rats in these experiments was in all cases made by rubbing a trace of the plague material on to the abraded surface (on which several superficial crossed incisions had been made) of the skin at the root of the tail, the hairs of this place having been previously removed with scissors. Whenever this inoculation was performed in the middle line the inguinal glands became subsequently involved in both groins, but when the inoculation was not in the middle line only the inguinal glands corresponding to the inoculated side were found affected. The change in the glands consisted of enlargement, one or another gland showing at the same time great congestion and even

hemorrhage to a greater or smaller extent. The loose connective tissue around the gland was always congested, and sometimes, though not always, œdematous. Sections through the glands and through the surrounding tissue showed invariably extensive necrosis of the lymphatic or adenoid tissue, with a large amount of blood diffused in it and in the medullary sinuses. The large blood-vessels of the medulla were greatly distended with blood. Both in the cortex and in the medulla the lymph-sinuses in places—particularly in the cortical portion—were filled with continuous masses of B. pestis forming definite plugs. It was easily recognised that the individual bacilli were embedded in a hyaline ground substance, thus forming true zoologea; the lymphatics both going to and coming from the gland—*i.e.*, the afferent and efferent vessels—were distended by and filled with leucocytes and numerous masses of B. pestis, or they were almost entirely injected with masses of the latter. Similarly, the lymph spaces of the surrounding fat tissue were in some instances literally filled with the bacilli. That the lymph vessels passing to the glands should be found containing abundance of B. pestis was to be expected since the latter would readily be carried from the inoculated spot of the skin of the tail to the lymph glands. Also it was to be anticipated that B. pestis would readily multiply in these lymph vessels, in the lymph spaces of the groin, and in those of the gland itself, and thus produce continuous masses filling these lymphatics. But what was not looked for, and which is a point of great interest, is the fact that all the venous blood vessels, including many capillaries of the tissue surrounding the gland, likewise contained large and small continuous streaks and masses of B. pestis. Such a condition is not or is only very rarely present in other organs. It is not observed either in the kidney or intestine or lung, organs, that is, which are always found more or less congested; and only in few instances have I seen the intralobular capillary blood vessels of the liver containing groups and streaks of plague bacilli. It follows, therefore, that the state of the blood vessels around the inguinal glands is entirely different from the state of the blood vessels obtaining in other organs; and, further, that this peculiar state of the venous vessels around the gland—viz., their containing large and small masses of B. pestis—is due to the B. pestis being absorbed and carried from the seat of inoculation directly by way of the veins. The cutaneous injury, above described, would no doubt involve many superficial veins, and owing to the state of the inguinal glands—viz., great swelling and necrosis—the circulation of blood in them would become impeded. This in its turn would affect and impede the circulation also of the surrounding tissue, hence in many of them stasis of blood and multiplication of the B. pestis would be the result.

2. The next organ in importance is *the spleen*. This organ is generally considerably enlarged, dark in colour, and firm; on a cut being made into its substance no fluid (blood) oozes out. This latter condition of the organ is in contrast with that in septicæmia and other diseases in which, the spleen being large and dark owing to hyperæmia and active congestion, there is always a quantity of blood oozing out from the spleen's cut surface. On examining

microscopic sections through the "plague spleen" such as is in question the blood vessels and blood spaces of the pulp are found greatly distended by blood which mostly is not in a fluid but in a clotted state; in fact there is extensive infarct. In many instances there is indication of necrosis and breaking down of pulp tissue of the spleen, but only in small microscopic foci. As regards the distribution of B. pestis in the spleen, these micro-organisms are found almost everywhere and in great abundance; in a scattered manner, but particularly in smaller and larger connected masses, in streaks and clumps in the blood vessels (stasis), and in amongst the pulp tissue in which breaking-down process is observed. On careful inspection the streaks and clumps of B. pestis are seen to be really contained within the blood spaces of the pulp tissue where this reaches an extensive degree, as for instance in the necrotic nodules of the spleen in the subacute form in guinea pigs. The blood spaces show in places an almost perfect natural injection with B. pestis.

3. *The lungs* are greatly congested either uniformly through lobes or limited to one or another lobule; in the latter case hæmorrhages into the infundibula and alveoli are not infrequently to be met with. The large and small vessels, *i.e.*, capillaries of the alveolar wall, are distended, much coiled and twisted, and filled with blood. In many instances some lobules and even lobes show consolidation of two kinds:

(*a*) patches in which all vessels are filled with blood in stasis, the central point being a bronchus distended by and filled with debris in which numerous B. pestis in masses are recognisable;

(*b*) irregular patches in which a number of alveoli are filled and distended by leucocytes; plague bacilli are not numerous in this second form of consolidation.

In last year's report I have described these changes in a more advanced stage of the subacute form.

4. *The liver* shows extensive areas, in which the capillary blood vessels of the lobules are distended and filled with blood; in some parts the blood is in stasis, the central vein being greatly distended and filled with coagulated blood. This is always associated with extensive breaking down and coagulation-necrosis of the parenchyma. It is for this reason that such parts appear opaque and more or less grey as compared with other neighbouring congested (red) parts. Plague bacilli are numerously present, particularly in the intralobular blood capillaries of the infarcted parts, which appear as if injected with plague bacilli.

5. *The kidneys* are generally enlarged and much congested. Sections of them show the blood vessels of the cortex, including the glomeruli, and of the medulla distended and filled with blood; in some portions of the cortex capillary hæmorrhages may also be noticed. B. pestis in groups are found in the glomeruli and particularly in the larger vessels of the cortex and medulla, where they form connected streaks and clumps. The epithelium lining

the convoluted tubes is generally in a state of more or less distinct granular degeneration. What is of great interest is that Plague bacilli can be found in the space of the Malpighian corpuscles, in some convoluted tubes, and in some uriniferous tubes of the medulla. It is therefore clear that plague bacilli may appear also in the urine of the bladder.

6. As already mentioned the *small intestine* is congested and contains sanguineous mucus. Sections of the gut show that the vessels of the mucosa are distended and filled with blood, with capillary hæmorrhages into the tissue; the epithelium of the surface is detached and wanting in many parts, and here the tissue of the mucosa is breaking down; the epithelium lining the crypts of Lieberkühn is detached and disintegrating. Plague bacilli are found in great numbers and masses in the superficial parts of the broken-down mucosa; where this is denuded of its epithelium there may be a continuous layer of these bacilli, all showing beautiful bipolar staining. It is clear therefore that the bowel discharges of such an animal would be containing plenty of B. pestis.

From these descriptions it is seen that in the acute and typical form of plague such as in rats follows the cutaneous inoculation of small doses of virulent B. pestis the changes in the different organs are generally severe and very pronounced, and that the distribution and multiplication of the B. pestis in these organs is of a very intensive nature.

II.—*Mice inoculated cutaneously with the virulent type of B. pestis.*

The conditions of the organs in the mouse are of a character which may briefly be described as an exaggeration in intensity of those observed in like circumstances in the rat. In all organs distension of the blood vessels with hæmorrhages is a dominant feature; and besides, the inguinal lymph glands and the spleen may be said to be practically crowded with masses of B. pestis, which are in all parts in continuous masses and in some places may almost entirely obscure the tissue.

1. *The inguinal glands* corresponding to the inoculated side, the cortical as well as the medullary lymph sinuses, are practically injected with B. pestis. Also in the lymphatic tissue of the cortex and medulla masses of B. pestis can be seen everywhere. What is left of the lymph tissue is necrotic in many parts. Not only the lymph vessels and lymph spaces of the gland itself but those also of the surrounding tissue show distension and almost complete injection with B. pestis.

2. In *the spleen pulp* there exists a continuous network of streaks and irregular masses of plague bacilli, the blood vessels of the pulp being greatly distended and filled with blood.

3. *The lungs* show uniform distension and filling of blood vessels with blood, in many places within them are found continuous masses of B. pestis; some capillaries and small veins appear almost injected, *i.e.*, completely filled, with these bacilli.

4. The like is the case with *the liver*, where the capillaries between the columns of liver cells are in many parts continuous masses of plague bacilli; the liver cells at the same time showing granular degeneration.

5. In *the kidney* all parts are uniformly congested, with many capillary hæmorrhages; many vessels of the cortex as also of the medulla are injected with plague bacilli. This is very strikingly shown in some of the Malpighian tufts and in their afferent and efferent vessels. The masses of bacilli being stained blue—methylenblue—the specimen now looks, under moderate magnification, as if some of these vessels had been actually injected with blue colouring matter. Granular degeneration and breaking down of the epithelium is seen almost everywhere in the convoluted tubes. Plague bacilli are seen in the uriniferous tubules both of the cortex and the medulla.

In respect of the rapid absorption and multiplication of plague bacilli in the inguinal glands after cutaneous inoculation, their rapid distribution all through the viscera and their enormous multiplication therein, the mouse is undoubtedly the animal offering the best nidus for the growth and multiplication of B. pestis. The above description applies equally to mice dead within 40 hours and to those dead within 60 or 66 hours.

III.—*Rats inoculated cutaneously with attenuated plague, type No. 2.*

As was mentioned in the experiments already described, death of such animals was delayed, and, except as regards the inguinal bubo and spleen, they showed comparatively few changes in their viscera. The changes consisted of a more or less general congestion, less in intensity than in the animals dead of the virulent type. The inguinal glands presented very much the same character as after cutaneous inoculation with plague of the virulent type, and also the spleen was in some instances found enlarged dark and firm, in others only slightly or not appreciably so.

Examination of sections through the hardened organs of rats dead after cutaneous inoculation with plague of type No. 2 was undertaken in a number of instances. The rats thus minutely examined were :—

Rat 1K, experiment 7.
Rat 1L, experiment 8.
Rat 1O, experiment 11.
Rat 1Q, experiment 13.
Rat 1R, experiment 14.

Rat 1K : (1) The *bubo* showed in the lymph gland hæmorrhage, and the blood vessels generally distended with coagulated blood; cortical lymph follicles necrotic in many points; cortical sinuses full of B. pestis; surrounding lymph vessels either filled with B. pestis or with leucocytes and B. pestis together; surrounding blood vessels greatly distended with blood.

(2.) *Spleen*: Large blood vessels filled with coagulated blood; pulp spaces distended by blood; most Malpighian corpuscles shrunk and small, showing necrosis in one or the other part. B. pestis here and there only in small groups in necrotic parts.

(3.) *Liver*: Numerous large blood vessels distended and filled with coagulated blood; within the liver lobules and more or less continued from the interlobular vessels were large irregular spaces filled with coagulated blood; liver cells showed granular degeneration; B. pestis difficult to find, if any.

(4.) *Lung*: General congestion, hæmorrhage in some parts; infundibula and small bronchi filled with leucocytes and fibrin; B. pestis difficult to find, if any.

(5.) *Kidney*: Large blood vessels distended and filled with blood; glomeruli of Malpighian corpuscles swollen, capillaries containing moderate amount of blood. B. pestis difficult to find, if any. The convoluted tubes appeared in most parts filled with hyaline casts, the lining epithelium fairly well preserved.

Rat 1L: (1.) *Bubo.*—Lymph vessels and lymph spaces around the glands injected and distended with B. pestis; the blood vessels of the gland itself greatly distended by blood.

(2.) *Spleen*: All blood vessels and blood spaces distended by blood; B. pestis only in small masses and not numerous.

(3.) *Liver*: Capillaries of the lobules much distended by blood; liver cells contained fat globules and many of them showed granular disintegration. Some capillaries—but not in many places—contained plague bacilli.

(4.) *Lung*: Great congestion in all blood vessels; hæmorrhage in some alveoli; no B. pestis discernible.

(5.) *Kidneys*: Great congestion of cortical vessels, in some places hæmorrhage; epithelium of convoluted tubes disintegrating; B. pestis to be found only in large vessels amongst the blood corpuscles.

Rat 1O: (1.) *Bubo.*—Almost complete necrosis due to infarct; masses of B. pestis in the cortical lymph sinuses and adjoining cortical necrotic parts.

(2.) *Spleen*: Infarct, blood vessels full of coagulated blood; Malpighian corpuscles shrunk and partially necrosed. B. pestis few, chiefly in necrotic parts of Malpighian corpuscles.

(3.) *Liver*: Infarct; bacilli very sparse, if any.

(4.) *Lung*: General congestion, some infundibula filled with fibrin and leucocytes. B. pestis very sparse, if any.

(5.) *Kidney*: Slight congestion, only larger vessels distended by blood. B. pestis very sparse, if any.

Rats 1Q and 1R differed in no way from the previous rats, except that the inguinal lymph glands showed extreme filling of the cortical lymph sinuses with masses of B. pestis : so also the lymph vessels around the glands were partially or wholly filled with B. pestis.

IV. — *Mice inoculated cutaneously with B. pestis of attenuated type.*

There was no difference, in the condition of the organs and in the wide and copious distribution in them of B. pestis, between mice of this series and the mice described in reference to the virulent series. The extreme prevalence of B. pestis in connected masses in the lymph spaces and lymph sinuses of the bubo, in the spleen pulp, in the vessels of the liver and lung is a remarkable feature ; just as conspicuous as that described of the mice in connexion with the virulent type of B. pestis.

From this it appears that as regards the mouse both types of plague act in the same manner ; that for both types of plague bacilli the tissues of the mouse offer a most excellent nidus for growth and multiplication. But it is different with the rat. In this animal a distinction between the two types can be made in view of the result of the changes produced in the spleen and by the distribution of the B. pestis in this organ, in the lung and liver, and in the blood in general.

In the attenuated type the spleen of the rat is in a large percentage of cases only slightly enlarged or not appreciably so, as will readily be understood from the description of the microscopic examination of the organ ; not only was there found stasis and coagulation of the blood in most vessels, but also a distinct shrinkage of the Malpighian corpuscles due to necrosis. The number of bacilli in the spleen was small and not to be compared with what is the general rule in the case of the virulent type of plague. As regards the liver, lung, and kidneys the absence of any appreciable number of B. pestis appears a noteworthy feature.

Since the inguinal bubo (*i.e.*, the proximal local effect), contains just as vast an amount of B. pestis as in the case of the virulent type, the conclusion is justified that in the attenuated type the condition of the organs (congestion, hæmorrhage) is mainly toxic ; that is to say is due to absorption into the circulation of the toxin *formed in the bubo* by the B. pestis. Further it appears that in its attenuated type B. pestis does not find in the viscera suitable conditions for its existence and multiplication as does the B. pestis of the virulent type ; and that owing to B. pestis of the virulent type thriving and multiplying well in the viscera the amount of toxin circulating in the system in animals inoculated with it must be greater than in the case of the attenuated type. This would not only account for the more rapid course and more rapidly fatal issue of the disease in the former case, but would seem to indicate that in the attenuated type the

delayed death permits sustained action of the toxin enabling it to produce the conspicuous necrotic changes in the bubo, in the spleen, and in the liver upon which stress has been laid.

One further important consideration deserves notice. Namely, that owing to the generally copious presence of B. pestis in the vessels of the viscera (lung, intestine, kidneys) of animals inoculated with the virulent type, the excretions of these rats would be liable to be charged with the contagium and to be to a corresponding extent dangerous; whereas with the attenuated type the excretions of the rats, as judged by the above description of the microscopic character of their viscera, would seem to be but sparsely charged with plague contagium, and with contagium not necessarily as dangerous to the human subject.

No. 4.

App. B, No. 4. Characters by which Streptococci and Staphylococci may be differentiated and identified; by Dr. Gordon.

REPORT of some CHARACTERS by which various STREPTOCOCCI and STAPHYLOCOCCI may be DIFFERENTIATED and IDENTIFIED; by Dr. M. H. GORDON.

CONTENTS.

I.—SCOPE OF THE PRESENT REPORT.

II.—SEARCH FOR TESTS WHEREBY TO DIFFERENTIATE STREPTOCOCCI.

III.—APPLICATION OF SUCH DIFFERENTIAL TESTS TO STREPTOCOCCI IN GENERAL.

IV.—DIFFERENTIATION OF STAPHYLOCOCCI.

V.—CONCLUSIONS.

SECTION I.

REASONS THAT NECESSITATED SCRUTINY OF THE CHARACTERS OF STREPTOCOCCI AND STAPHYLOCOCCI. SCOPE OF THE PRESENT REPORT.

IT was shown in my last report that the spraying of fine particles of saliva from the mouth in the acts of coughing, sneezing, and loud speaking had an important bearing on the subject of air-borne infection, and a test was described by means of which the presence of such particles of saliva in air could be detected. The test referred to was a bacteriological one, and the process by which it was arrived at was as follows. Samples of saliva from various normal individuals were subjected to high dilution and submitted to bacteriological examination, with the result that certain micro-organisms were found to be constantly present therein in large numbers. The micro-organisms in question were streptococci, and the particular micro-organism that appeared to be more characteristic of saliva than any other was Streptococcus brevis, which, in each of the 25 samples of saliva examined, was present to the extent of at least 10,000,000 per cc. of saliva. The facts thus ascertained were next utilised for the purpose of demonstrating the presence of particles of saliva in air. I was able to show that immediately *before* sustained speaking was practised in a given room no salivary streptococci

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were to be obtained from the air of the room; and further that *after* sustained loud speech had been indulged in within the same room streptococci indistinguishable in all respects examined from salivary streptococci, and in particular streptococci indistinguishable in the same sense from S. brevis of saliva, could be recovered from the air of the room by exposing culture media in the vicinity of a person who performed there the act of speaking. The speaking experiments in question were parallel with those of Flügge, and especially of Koeniger, in which B. prodigiosus was used as an index of infection. Koeniger, it will be remembered, by artificially infecting his mouth with B. prodigiosus, proved that particulate matter sprayed from the mouth in the act of speaking was capable of spreading through the air of a room up to a point 40 feet away from the speaker. To a like distance also saliva emitted from the mouth during an hour's loud speaking was traced by application of my streptococcus test.

The characters by which streptococci of saliva were identified were of two kinds. In the first place the morphological appearance of the growth in broth and on agar at 37° C. was observed. Secondly, the biological characters of the streptococci were examined. In subculture it was found that in litmus-milk streptococci characteristic of saliva produce an acid reaction, and in the majority of cases a firm clot. These two effects of the growth in litmus-milk were particularly constant in the case of S. brevis of saliva. Another characteristic of the latter micro-organism was that it was found to be capable of discharging the colour of neutral red broth, when growing in that medium under anærobic conditions at 37° C. Owing to the constant and abundant presence of S. brevis in saliva, the same change in neutral red broth was found to be produced by minute quantities of crude saliva. This last result suggested that the method previously applied for detecting droplets of saliva in air, namely, by exposing dishes filled with ordinary broth and subsequently incubating the medium anærobically at 37° C., could be materially improved by tinting the broth thus exposed with neutral red.*

In the course of the experiments in which the streptococcus test for saliva was applied, it was found that a certain streptococcus of other than salivary origin occurred not infrequently both in the air of rooms and in the open air. It became necessary, therefore, to distinguish between this "air streptococcus" and streptococci characteristic of saliva. Fortunately the differentiation was found to be easily accomplished; not merely because of minor morphological points of distinction, but chiefly by reason of the fact,

* Recent experience, however, has shown that neutral red broth is not always the most suitable medium for detecting the presence of salivary streptococci in air. Thus in a series of examinations of vitiated air passing out of the Debating Chamber of the House of Commons I have found that salivary streptococci are best detected in the said air during debates by exposing plates containing agar or, if the exposure is a long one, the medium of Dopalski and Conradi. After exposure, these plates of solid media are incubated aerobically at 37° C. for 48 hours, and the streptococcus colonies present are subcultured in broth and then subjected to the nine differential tests described in the present report.

frequently verified, that the air streptococcus produced no change of reaction and no clot when growing in litmus-milk, and also that it failed to change the colour of the medium when growing in neutral red broth. These negative characters of the air streptococcus admitted, therefore, of ready application for the purpose of distinguishing that micro-organism from streptococci characteristic of human saliva.

But in spite of the definite character of these distinctions between the air streptococcus and streptococci of saliva, it was desirable that search should be made for further tests by which streptococci of salivary or other origin could, if possible, be differentiated and identified. Previous experience had shown that it was by means of their biological and especially by their biochemical characters that the hope lay of differentiating streptococci. Accordingly an investigation was begun in order to examine the action of various streptococci on various organic compounds of known chemical composition, but easily decomposable. The test was made in the following way. Faintly alkaline sugar-free broth was tinted with litmus, charged with the organic substance to be tested, and, after inoculation with a given streptococcus, was incubated aerobically for three days at 37° C. Under these circumstances it was found that whereas in some cases no change was produced in the reaction of the medium, in others, where decomposition of the organic substance under trial was effected by the action of the streptococcus, such decomposition was notified by the development of a distinct acid reaction in the broth. But although the change in reaction was extremely marked in some instances—the colour being changed from purple-blue to brilliant red—no gas formation was observed, a circumstance that distinguishes the action of streptococci on certain of these substances from that of several members of the Coli-typhoid family of bacteria.

At the time of writing my report I had only been able, among organic substances, to examine glucose and lactose in the above way; and I was able to report that while all the examples of salivary streptococci tested had been found to produce an acid reaction when growing in broth containing 2 per cent. of either glucose or lactose, the air streptococcus, though it produced an acid reaction in the case of glucose, produced no such effect in the case of broth containing lactose. This result was in accord with the previously observed failure of the air streptococcus to produce a change of reaction when growing in litmus milk. Investigation in the above sense was afterwards extended, and at the time of going to press I was able to insert an addendum briefly summarising further results. I stated that the action of 12 streptococci from various sources had been tried on a further number of substances belonging to the carbohydrate and allied series. In the case of fructose, mannose, maltose, and galactose, all the streptococci in question produced an acid reaction; on the other hand, in the case of starch and dulcite no change of reaction took place. In the case of the following substances, however, saccharose, raffinose, inulin, mannite, salicin, and coniferin, some streptococci produced an acid reaction, whereas other streptococci,

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though growing in the medium, failed to produce any such effect: So that these substances promised to have a valuable application for the purpose of differentiating streptococci.

This, therefore, was the stage of the enquiry at which my last report ended. In the present report, the result of my further search among organic compounds of carbon for substances lending themselves to the differentiation of streptococci under the conditions described will be given in greater detail. Reference will also be made to the result of the trial of certain other cultural tests of biological characters in respect of which streptococci have been compared. Secondly, the result will be described of the application of a selection of nine differential tests to a large number of streptococci isolated chiefly from the saliva of normal individuals but also from the human body in disease, as well as to streptococci from air, dust, and other sources. In the case of streptococci isolated from disease processes and found to possess virulence, it has been possible to ascertain the nature of the response given to the nine differential tests by a streptococcus before and after passage through an animal, and accordingly this point has been examined. It may be said at once that as a result of these various procedures the value of the nine tests in question for differentiating and identifying various streptococci has been very definitely established.

While the search for means whereby particles of saliva floating in air may be detected has led to the developments referred to, investigation for this purpose has not been confined to the study of streptococci. In the account of the investigation of various samples of saliva given in my last report, mention was made of the fact that in all the samples examined staphylococci were present in great abundance and were only less numerous than streptococci. In all 25 samples of saliva submitted to examination by means of the culture test, staphylococci were proved to be present to the extent of over 1 million per cc., and in exceptional cases even exceeded streptococci in abundance. It was of considerable subsidiary importance, therefore, to ascertain whether any particular kind or kinds of staphylococci were by reason of their constancy and abundance in saliva characteristic of it, and if so, whether these staphylococci could be identified and used as a secondary means of detecting the presence of droplets of saliva in air.

It was not, however, solely for this purpose that an enquiry into the relations of members of the staphylococcus group has been rendered necessary. Infective material may be imparted to air by means other than by particles of saliva. For instance, minute particles of skin and scurf are liable to be shed from the surface of the body, and it is possible that under certain circumstances, morbific virus may be communicated to the atmosphere in this way. A preliminary examination was therefore made to ascertain if any micro-organisms occurred habitually in association with particles of skin and scurf, and if so whether such micro-organisms could be identified and their presence applied as a test whereby particles of skin and scurf floating in air could be detected. The

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result of this examination was to show that certain micro-organisms do occur on particles of skin and scurf, and in both instances the micro-organisms found were staphylococci. Investigation of the staphylococci has, therefore, been undertaken not only in order to obtain a second test whereby droplets of saliva may be detected, but also with view to detecting the presence of particles of skin and scurf. Staphylococci, however, have a wide distribution in nature and are especially abundant in air. Moreover, the points to which attention has commonly been given in attempt to distinguish staphylococci were found to be insufficient for the object in view in the present instance. It has been therefore necessary first of all to ascertain by what characters in addition to those at present commonly taken account of for this purpose, staphylococci may most conveniently and sharply be differentiated, and an enquiry to determine this matter was instituted on similar lines to the enquiry already described in the case of the streptococci. In a preliminary series of tests the action of six several staphylococci was tested on 20 different organic substances. The medium employed for this purpose was similar to that previously used in the case of streptococci. The proportion in which the substance to be tested was added to the medium was also the same as before, and, as in that case, the question to be determined was whether or no a given staphylococcus produced an acid reaction in relation with a given organic substance. As a result of these and other tests in which staphylococci have been compared with one another, nine differential tests have been selected, and a series of staphylococci have been submitted to them with results that will afterwards appear.

SECTION II.

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Tests for Differentiating Streptococci.

In the following investigation the "common" medium employed was ordinary nutrient broth freed from sugar by cultivating B. coli therein for three days at 37° C. At the end of that time the broth was sterilised, cleared, made slightly alkaline, and tinted with litmus. The proportion of litmus added was ten per cent. of a watery solution of this substance. A control experiment was then made in all early tests by cultivating streptococci in the medium in order to make sure that no acid reaction was produced by their growth in the medium *per se*. The result of such tests was invariably negative. The proportion in which a given organic substance was added to the broth was two per cent. in the experiments now to be related, but in later routine practice one per cent. has been found sufficient. After adding the organic substance in the proportion stated, the medium was tubed and sterilised by steaming for half an hour on two successive days. Litmus broth prepared in this way and containing the substance to be tested was inoculated with a given streptococcus and incubated for three days at 37° C. In cases where an acid reaction is produced by the growth of a streptococcus, such reaction is often visible already after 24 hours; the reason of the three days' incubation is to enable weaker streptococci to produce the reaction should they be capable of doing so. The value of a time limit of three days also increases the differential value of a negative response to the tests.

In the present report all tests in which streptococci were tried against organic substances for acid-production, were made in ordinary meat-broth that had been previously freed from sugar by cultivating B. coli therein in the way above described. Dr. Houston, however, has recently found that Lemco-broth suffices for the same purpose. The advantages of Lemco-broth are that the medium being free of sugar, there is no necessity for cultivating B. coli in it before use; and, secondly, Lemco-broth is cheaper than meat-broth. Having recently tested a number of streptococci and staphylococci in Lemco-litmus-broth containing one or another of the various organic substances hereafter selected for routine application in the case of these two classes of cocci respectively, I can now recommend the routine use of Lemco-broth for this purpose. The only difficulty I have had has been in exceptional cases when a specially delicate streptococcus might, perhaps, produce a positive reaction against a certain organic substance in coli-broth, but not in Lemco-broth. Besides the saving in time and expense effected by its employment, the Lemco medium has the advantage of being uniform in constitution and alkalinity when always made according to the following formula, for which I am indebted to Dr. Houston:—

Lemco	1 per cent.
Peptone	1

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Test organic substance	...	1	per cent.
Sodium bicarbonate ...	...	0·1	„

plus 10 cc. per cent. of a 10 per cent. watery solution of ordinary olid litmus.

It may, perhaps, be mentioned also that oblong tins fitted with sliding removable partitions have been found to be of great convenience for examining streptococci by these tests.

For the purpose of the enquiry 10 streptococci were consistently employed, and they were selected on account of their being, so far as could be judged at the time, fairly representative of the different types of streptococci found in nature. The several micro-organisms were from sources as follows :—

I.—Dust of a laboratory floor.

II.—Streptococcus which were present in numerous colonies on a Drigalski and Conradi plate that had been inoculated with a dilution of a typhoid stool.

III.—Streptococcus cultivated from the liquor of an oyster suspected of receiving pollution from sewage.

IV. & V.—Streptococci from the mouths of newly-born infants.

VI.—Streptococcus isolated from normal skin.

VII.—Streptococcus obtained in pure culture from the heart's blood of a patient who had succumbed during an attack of pleurisy.

VIII.—Streptococcus from the pus of an abscess. The abscess had developed in the leg of a youth subsequent to injury from a splinter of wood.

IX.—Streptococcus isolated from a sample of milk.

X.—Streptococcus isolated from 50 litres of the open air of London, E.C. It is a typical example of the air streptococcus.

Nos. II., VII., and VIII. were kindly given me by Dr. Andrewes

All ten of the above micro-organisms were non-motile, retained Gram's stain, and were morphologically undoubted examples of streptococci. Alone of the ten, No. 1 produced liquefaction of gelatine visible already after two days at 22° C. Before being subjected to the several tests, each of these streptococci was plated and stock cultures made from a single colony so as to ensure the purity of the culture. A sub-culture of each streptococcus was then injected into a mouse, but no lesion resulted. I have little doubt, however, that had streptococci 7 and 8, especially the former, been tested in this way when originally isolated from their respective sources, pathogenic effects would have been demonstrated.

Trial was first made of substances belonging to the carbohydrate group.

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CARBOHYDRATES.

1. *Monosaccharides*:—

(*a*) *Pentoses.*—Only one substance of this class was examined, namely, rhamnose or isodulcite, $C_6H_{12}O_5$. An acid reaction was produced by streptococci I. and II., but not by the rest.

Broth was prepared with arabinose and xylose respectively, but as the colour of the litmus was found to have become changed in the steaming, the action of the streptococci on these substances was not examined.

(b.) *Hexoses* $C_6H_{12}O_6$.—No less than 4 substances of this class were tested, namely, glucose, fructose, mannose, and galactose. I found that in the case of all these sugars, each of the ten streptococci produced a clear acid reaction.

2. *Disaccharides.*—In the case of maltose, $C_{12}H_{22}O_{11}+H_2O$, all ten streptococci produced an acid reaction. Both saccharose, $C_{12}H_{22}O_{11}$, however, and lactose, $C_{12}H_{22}O_{11}+H_2O$, were found to be of differential value; some streptococci producing an acid reaction, whereas others failed to do so.

3. *Trisaccharides.*—Raffinose, $C_{18}H_{32}O_{16}+5H_2O$, the only substance tested, was found to have a differential value.

4. *Polysaccharides* $(C_6H_{10}O_5)_n$.—The following were tried: Starch, inulin, dextrin, arabin and glycogen. In the case of starch, owing to the fact that if a larger quantity was used, the medium became solid, the proportion added to the broth was only ½ per cent. No acid reaction was produced by the streptococci in the case of starch, arabin, and glycogen. In dextrin all produced an acid reaction. On the other hand inulin brought out a difference between the streptococci.

GLUCOSIDES.

Eighteen substances of this class were obtained for testing in the manner described. Five of them, namely, phloridzin, mucin, tannin, quercitrin, and sabbatin were altered in the steaming and were therefore discarded. The streptococci produced no change of reaction in the case of the following: Methyl glucoside, $C_7H_{14}O_6$; saponin, $C_{32}H_{54}O_{18}$; jalapin, $C_{34}H_{56}O_{16}$; convolvulin, $C_{31}H_{50}O_{16}$; and hesperidin, $C_{22}H_{26}O_{12}$. The remaining 8 glucosides, however, were found to have a differential value; these were:—

Amygdalin, $C_{20}H_{27}NO_{11}+3H_2O$.

Arbutin, $C_{12}H_{16}O_7$.

Coniferin, $C_{16}H_{22}O_8+2H_2O$.

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Digitalin, $C_{99}H_{46}O_{13}$.
Helicin, $C_{13}H_{16}O_7 + H_2O$.
Populin, $C_{10}H_{22}O_8$.
Salicin, $C_{13}H_{18}O_7$.
Syringin, $C_{17}H_{24}O_9$.

Polyatomic alcohols.—The following were tried with the results stated:—

1. Glycol, $C_2H_6O_2$.—All the streptococci failed to produce an acid reaction in the case of this diatomic alcohol.

2. Glycerine, $C_3H_8O_3$.—This triatomic alcohol, on the other hand, was of differential value.

3. Erythrite, $C_4H_{10}O_4$.—The tetratomic alcohol tested was of no differential value.

4. Mannite, $C_6H_{14}O_6$.—This hexatomic alcohol was of differential value. Of its two isomers, sorbite, $C_6H_{14}O_6$, was of less differential value than mannite; and dulcite, $C_6H_{14}O_6$, was of no differential value at all.

The results obtained up to this point are summarised in the appended Table, in which the reaction given by each of the ten streptococci to each of the 33 substances tested may be readily seen.

TABLE.

Showing the action of Streptococci on various Organic Substances.

Streptococci.		Carbohydrates.														Glucosides.												Polyatomic Alcohols.					
No.	Source.	Rhamnose.	Glucose.	Fructose.	Mannose.	Galactose.	Saccharose.	Lactose.	Maltose.	Raffinose.	Starch.	Inulin.	Dextrin.	Glycogen.	Arabin	Amygdalin.	Arbutin.	Coniferin.	Convolvulin.	Digitalin.	Helicin.	Hesperidin.	Jalapin.	Methyl-Gl coside.	Populin.	Salicin.	Saponin.	Syringin.	Glycol.	Glycerin	Erythrit.	Dulcite.	Sorbite.	Mannite.
I.	Dust	+	+	+	+	+	+	+	+	-	-	-	+	-	-	+	+	+	-	+	+	-	-	-	+	+	-	+	-	+	-	-	+	+
II.	Stool	+	+	+	+	+	+	+	+	-	-	-	+	-	-	+	+	+	-	+	+	-	-	-	+	+	-	+	-	+	-	-	+	+
III.	Oyster	-	+	+	+	+	-	+	+	-	-	-	+	-	-	-	+	+	-	+	+	-	-	-	+	+	-	+	-	-	-	-	-	+
IV.	Saliva	-	+	+	+	+	+	+	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
V.	Saliva	-	+	+	+	+	+	+	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-
VI.	Skin	-	+	+	+	+	+	-	+	+	-	-	+	-	-	-	-	-	-	?+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
VII.	Blood	-	+	+	+	+	+	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VIII.	Pus	-	+	+	+	+	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+
IX.	Milk	-	+	+	+	+	+	+	+	-	-	-	+	-	-	-	-	-	-	?+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
X.	Air	-	+	+	+	+	+	-	+	-	-	-	+	-	-	-	-	+	-	?+	-	-	-	-	-	+	-	+	-	-	-	-	-	-

The sign + indicates that a distinct acid reaction was produced by the streptococcus under the conditions of experiment.

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Other substances tried in litmus sugar free broth :—

1. *Acid amides.*—Caffein, asparagin and urea were tried but no change of reaction, alkaline or otherwise, was produced by any of the streptococci.

2. *Oils.*—Sperm oil and cod liver oil tested in the same way gave no definitely positive result.

Further tests tried :—

1. *Reduction of nitrate to nitrite.*—Ordinary broth tubes containing ·5 per cent. potassium nitrate were inoculated with each of the above streptococci and incubated at 37° C. for three days. On testing for nitrite at the end of this time, in no case was a positive reaction obtained. It will be seen later that staphylococci give a very different result to streptococci as regards this test.

2. *The production of sulphuretted hydrogen.*—Tubes of ordinary broth with the addition of ·1 per cent. lead acetate were inoculated with the streptococci. Some positive evidence of sulphide, *i.e.*, blackening of the lead precipitate, occurred in the case of streptococci I. and II. in the course of a week's incubation at 37° C. There was also an indication of a positive result in the case of streptococcus No. III. The rest were negative. This test, therefore, would seem to be of some differential value.

3. *Change of colour in broth containing one or another aniline dye.*—In order to ascertain if aniline dyes other than neutral red might be of use for differentiating streptococci, trial was made of indigo sulphate, methylene blue, and azur. Dr. Grübler was good enough to forward me the latter two dyes for this purpose at my request. Ordinary broth tinted with the dye to be tested was used. The results given by the ten streptococci after 48 hours' growth aerobically at 37° C. is seen in the following table, where the result is also given of the action of the same micro-organisms on neutral red broth anaerobically within the same limit of time.

Streptococci.		48 hours' growth at 37° C.			
		Anaerobically.	Aerobically.		
No.	Source.	Neutral Red.	Indigo Sulphate.	Methylene Blue.	Azur.
I.	Dust	+	+	+	+
II.	Stool	+	+	+	+
III.	Oyster	-	-	-	-
IV.	Saliva	+	-	-	..
V.	Saliva	-	-	-	-
VI.	Skin	-	-	-	-
VII.	Blood	-	-	-	-
VIII.	Pus	-	-	-	-
IX.	Milk	-	-	-	-
X.	Air	-	+ Slight.	-	+ Slight.

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The positive sign indicates in the case of the neutral red broth column that the colour of this medium was changed from cherry red to orange green; in the case of the other three dyes the same sign signifies that the blue colour of the broth was bleached. The results show that although all the dyes have some differential value, there appears to be no sufficient cause for adopting an aerobic routine test with one of the other dyes in place of the neutral red test which I have been in the habit of applying anaerobically. The positive result given by one of the two salivary streptococci in the latter medium also emphasised its relative superiority for the special purpose of the present enquiry.

General bearing of these results on the main object of the enquiry. Tests selected for routine employment.

It has been found, therefore, that a number of substances are available for the purpose of differentiating streptococci. As a matter of routine, however, it is not practicable to apply all the tests in which the ten streptococci have been found to differ. A selection has been necessitated, and bearing in mind the main object of the present enquiry, seven of the principal differential substances have been selected for routine employment in addition to the tests in litmus milk and neutral red broth already in use. The seven substances selected are saccharose, lactose, raffinose, inulin, salicin, coniferin, and mannite. The manner of applying each of these substances as a differential test for streptococci is that described above. As additional tests also in special cases, rhamnose, glycerin, and sorbite may be us The remaining tests to which, from t value for differentiating st erential

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glucosides, the other aniline dyes examined, and the test in lead broth, have all for the present been discarded. It is conceivable, however, that on another occasion, and with another main object in view, one or more of these tests now discarded might, as likely to prove of more immediate value, be preferable to one or more of the tests adopted in the present instance.

Table.

Showing the reactions given by the 10 Streptococci in the 9 selected tests.

Streptococci. No.	Source	Saccharose.	Lactose.	Raffinose.	Inulin.	Salicin.	Coniferin.	Mannite.	Clo..	Neutral Red.	Remarks.
I.	Dust ..	+	+	−	−	+	+	+	+	+	Liquefies gelatin.
II.	Stool ..	+	+	−	−	+	+	+	+	+	No liquefaction of gelatin.
III.	Oyster ..	−	+	−	−	+	+	+	+	−	"
IV.	Saliva ..	+	+	+	+	−	−	−	+	+	"
V.	Saliva ..	+	+	+	−	+	−	−	+	−	"
VI.	Skin ..	+	−	+	−	+	−	−	−	−	"
VII.	Blood ..	+	+	−	−	−	−	−	−	−	"
VIII.	Pus ..	−	+	−	−	−	−	+	−	−	"
IX.	Milk ..	+	+	−	−	+	−	−	+	−	"
X.	Air	+	−	−	−	+	+	−	−	−	"

SECTION III.

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APPLICATION OF NINE SELECTED DIFFERENTIAL TESTS TO STREPTOCOCCI IN GENERAL.

SYNOPSIS.

I.—STREPTOCOCCI FROM THE HUMAN BODY IN HEALTH. THE CHARACTERS OF 300 STREPTOCOCCI FROM NORMAL SALIVA.

II.—STREPTOCOCCI FROM THE HUMAN BODY IN DISEASE. THE CHARACTERS OF STREPTOCOCCI FROM PNEUMONIC SPUTUM, FROM SEPTIC PROCESSES, AND FROM ULCERATIVE ENDOCARDITIS.

III.—THE EFFECT ON ITS BIOLOGICAL CHARACTERS OF PASSING A STREPTOCOCCUS THROUGH AN ANIMAL.

IV.—THE CHARACTERS OF STREPTOCOCCI FROM DIVERSE SOURCES.

Having obtained in the manner described a series of nine tests by means of which differences existing between the characters of various streptococci could be detected, and having found on repeating the tests three times over that each of the ten streptococci responded on each subsequent occasion to each test in the same fashion as it had done in the first instance, the next step was to isolate a large number of streptococci from different sources and to examine them in the same way. This has accordingly been done.

The sources from which streptococci have been isolated and subjected to the nine tests are various. In the first place trial has been made of streptococci obtained from the human body in health—chiefly up to the present from saliva. Secondly, streptococci isolated from the human body in disease have been examined, and, owing to the pathogenicity possessed by them, the opportunity was taken of examining the effect on their reactions of passing some of them through animals. Thirdly, the tests have been applied to streptococci obtained from different sources outside the human body, such as air, dust, milk, &c. The result of this procedure will now be described in detail.

PART I.—STREPTOCOCCI ISOLATED FROM THE HUMAN BODY IN HEALTH.

Streptococci isolated from saliva.—(*a*) At birth. The examination of the flora of the mouth of the newly born infant was originally undertaken to ascertain how soon streptococci made

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their appearance in the human mouth, and it is convenient to briefly refer to the result of this enquiry before proceeding further. Material was obtained through the kind co-operation of Dr. Urwick. The procedure was either to use a swab or, in a few cases, to take a loopful of mucus from the infant's mouth and to distribute it in broth. In all cases the following cultures were made from the material—a surface agar plate, an ordinary broth, and a neutral red broth culture. All the cultures were incubated at 37° C., the neutral red broth being placed under anaerobic conditions. The mouths of altogether 22 infants were examined in this way at stages from the moment of birth up to the fourth day. Some of the cases were examined on more than one occasion. The results are summarised in the following table.

TABLE.

Showing Result of Bacteriological Examination of the Mouths of Newly-born Infants.

No.	Age.	Sex.	Streptococci.	Staphylococci.	Bacilli.	Remarks.
1	At birth ..	Male ..	−	−	−	Sterile.
2	10 minutes ..	Female..	−	+	−	
3	20 minutes ..	Female..	−	+	−	
4	Ditto ..	Male ..	−	−	−	
5	30 minutes ..	Male ..	−	+	−	
6	Ditto ..	Female..	+	−	−	The air streptococcus.
7	35 minutes ..	Female..	−	−	+	? B Xerosis.
8	45 minutes ..	Female..	−	+	−	
9	5½ hours ..	Male ..	−	+	−	Twins.
10	Ditto ..	Female..	−	+	−	
11	7 hours ..	Male ..	+	+	−	S. Brevis of saliva.
12	8½ hours ..	Female..	+	+	−	Ditto
13	10 hours ..	Male ..	+	+	−	Ditto and S. Medius.
14	Ditto ..	Female..	−	−	−	Sarcinæ.
15	10¼ hours ..	Female..	−	−	−	
16	11 hours ..	Male ..	−	+	−	
17	18 hours ..	Male ..	+	+	−	S. Brevis and Conglom:
18	29 hours ..	Female..	+	+	−	S. Brevis, Medius, and Longus.
19	33 hours ..	Male ..	+	+	−	S. Brevis and Longus.
20	50 hours ..	Male ..	+	+	−	S. Brevis.
21	3rd day ..	Male ..	+	+	−	S. Brevis.
22	4th day ..	Male ..	+	+	+	S. Brevis and Conglom:

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It follows from these observations that at birth and for some hours after birth, streptococci do not occur in the human month. Omitting observation No. 6 in which the air streptococcus was found in the mouth of a child 30 minutes after birth, it is seen that the earliest case in which salivary streptococci were found was in a child aged seven hours. Other observations, however, show that so late as the 11th hour after birth streptococci may be absent. On the other hand, observations made on infants at a period later than 24 hours after birth showed that in all cases streptococci were present in the mouth.

In cases where streptococci were found they were isolated in pure culture and examined in respect of their growth in broth and on agar, and also as regards production of acid and clot in litmus milk and in reference to reduction of neutral red. As a result, their characters were found to be similar in these respects to those of streptococci obtained from saliva in adult life.

At birth, therefore, the same holds good for the mouth as Escherich showed to be the fact for the intestine. Alike as regards mouth and intestine, the particular micro-organism subsequently to become "indigenous" is absent, but by the end of 24 hours after birth the streptococcus is present in the mouth, and the bacillus in the intestine. In both these portions of the alimentary canal, therefore, a post-natal infection takes place which persists throughout life, a fact the full bearing of which we have still to discover.

The examination of the mouths of newly-born infants was made at a date anterior to the acquirement of the differential tests for streptococci described in the preceding section, and, consequently, only two of the streptococci isolated from this source that happened to have been kept in stock were subjected to the nine tests. These two streptococci were among the 10 selected as test streptococci in the enquiry described in the last section, and their characters will be found in the table there given.

(*b*) Saliva at ages ranging from 3½ to 64 years. Procedure. The method of isolating streptococci from saliva was similar to that described in my last report. In the present series in each case dilutions containing ·000,000,1, ·000,001, and ·000,01 cc. of freshly obtained saliva were examined. Each of these three amounts was inoculated into neutral red broth, and from the two larger quantities surface agar plates were also made. All cultures thus inoculated were incubated at 37° C., the neutral red broth cultures being placed under anaerobic conditions. At the end of 48 hours, surface agar plates were made from the latter. Streptococcus colonies representative of those present on the various agar plates were next subcultured into broth, and from the pure cultures in this way obtained subcultures were made in the nine test media.

It will be seen from the above description that no streptococcus examined could have been present to the extent of less than 100,000 per cc. of saliva.

The following table gives the age and sex of the various persons from whom saliva was obtained, with the number of streptococcus

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colonies subcultured from each sample and submitted to the nine tests :—

Age.	Sex.	No. of streptococci tested.	Age.	Sex.	No. of streptococci tested.
3½	Male	12	23	Female	8
5½	Female	9	25	"	9
13	Male	11	25	Male	14
14	"	12	27	"	14
14	"	14	28	"	14
15	"	17	30	"	11
16	"	17	32	"	15
18	"	12	35	"	12
19	"	16	40	"	21
20	"	[illegible]	45	"	11
21	"	21	64	Female	12

It will be seen from this table that samples of saliva were examined from 22 different persons of various ages. The average number of streptococci examined from each sample was rather over 13. The total number of streptococci subjected to the nine tests was 300.

General results.—The results which are recorded in the accompanying tables show that each of the 300 salivary streptococci examined responded in the same way in respect of two of the nine tests; namely, as regards saccharose and mannite. *Thus, while all produced an acid reaction in broth containing saccharose, not one of the 300 streptococci produced a change of reaction when growing in broth containing mannite.* It will be shown later that these two characters exhibited so uniformly by salivary streptococci may, on occasion, be of great use in distinguishing streptococci of saliva from certain streptococci of different origin.

Two of the nine tests, therefore, while serving to distinguish salivary streptococci from certain streptococci of other than salivary origin, fail to differentiate salivary streptococci from one another. This object, however, is amply accomplished by the seven remaining tests, for by their means the 300 streptococci under review are differentiated into no less than 48 different types.

For convenience of reference these 48 different types have been primarily arranged in eight groups according to the number of positive reactions shown to the nine tests. Each group is labelled with the numeral denoting the number of tests to which its streptococci give a positive reaction. Thus group 1 includes

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the streptococci positive to only one of the nine tests, group 2 streptococci positive to two tests, and so on. Altogether eight groups are arrived at in this way.

Coming next to the frequency of occurrence of the various groups, it is found that whether they are viewed from the point of view of the number of different types of streptococci they contain, or from that of the aggregate number of specimens, or from that of the aggregate number of samples from which such specimens were obtained, the same general order is seen. Of the eight groups under consideration, groups 4 and 5 come first, groups 3 and 6 come next, groups 2 and 7 next, and groups 1 and 8 are last. Thus there is a progressive diminution from the middle groups which are first, towards the groups at either extreme. The actual figures given by the eight groups are seen in the following table :—

Group number (positive reactions).	Types of Streptococci contained (Individual).	Number of Specimens (Aggregate).	Number of Samples from which latter were isolated (Aggregate).
1	1	10	6
2	4	24	16
3	9	47	37
4	12	90	51
5	12	81	46
6	6	34	25
7	3	11	10
8	1	3	2

In sub-dividing the eight groups in the tables, the order in which various types of streptococci are placed is in accordance with the relative frequency with which they have been found to occur in the 22 samples examined. The sub-divisions of the groups are denoted by letters attached to the group numerals; thus type 4a is the type of streptococcus in group 4 that occurred in a larger number of samples of saliva than did any other streptococcus of that group, and after 4a in the same respect come 4b, 4c, 4d, &c. in the order named.

Coming next to the important question of the frequency of occurrence of each individual type of strepto[illegible] be convenient to consider (1) the number [illegible] met with in the 22 samples of [illegible] the types which were found

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(1.) *Relative frequency of occurrence of the 48 different types of streptococci in the 22 samples of saliva.*

An examination of the table shows that the majority of the types of streptococci were rarely met with in the samples. Thus of the 48 different types distinguished—

10	types	occurred	in only	1 sample.
12	„	„	„	2 samples.
10	„	„	„	3 „
3	„	„	„	4 „
3	„	„	„	5 „
2	„	„	„	6 „
2	„	„	„	7 „
1	„	„	„	8 „
2	„	„	„	9 „
1	„	„	„	15 „
1	„	„	„	17 „
1	„	„	„	18 „

(2.) *Characters of the Streptococci most frequently found in Saliva.*

Notwithstanding that the number of types of streptococci distinguished by the nine tests is large, the number of the types that occur in saliva with sufficient constancy to justify their being considered characteristic of that secretion is comparatively small.

Two types of streptococcus occurred more frequently than any of the others. These two micro-organisms are the first in groups 4 and 5, namely, types 4a and 5a. Of 4a, altogether 41 specimens were obtained and they came from 18 of the 22 samples of salivia examined; of 5a, 43 specimens were obtained, and they came from 17 of the 22 samples examined. It follows from these figures that the two types in question were by far the commonest of all the 48 types obtained from saliva.

When the characters of these two streptococci (*4a* and *5a*) are compared, it will be seen that they possess four positive reactions in common; namely, acid production in saccharose and in lactose, clotting of milk, and reduction of neutral red. It is only in respect of their response to the raffinose test that a difference obtains between them.

The third commonest type of streptococcus is 3a, of which 24 specimens were obtained, and they came from 15 of the 22 samples of saliva. It should be noted that the three positive characters *exhibited* by this streptococcus, namely, the production of acid in *saccharose* and in lactose and the clotting of milk, are possessed by the two preceding streptococci.

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The fourth commonest type of streptococcus is 2a, 16 specimens of which were isolated from altogether nine of the samples of saliva. Its two positive reactions, namely, acid in saccharose and in lactose, are both possessed by the preceding three streptococci.

It is noteworthy that altogether no less than 124 of the 300 streptococci under review are referrable to the four preceding types.

The 10 types of streptococci most frequently met with in the samples examined are arranged in the following table, from which full particulars of their reactions may be seen.

Table.

Showing Reactions of the 10 types of Streptococcus found most frequently in the 22 samples of Saliva examined.

No.	No. of specimens.	No. of sources (i.e., different samples from which isolated).	Saccharose.	Lactose.	Raffinose.	Inulin.	Salicin.	Coniferin.	Mannite.	Clot.	N. red.	Salivary type re-established.
1	41	18	+	+	-	-	-	-	-	+	+	4a.
2	43	17	+	+	+	-	-	-	-	+	+	5a.
3	24	15	+	+	-	-	-	-	-	+	-	3a.
4	16	9	+	+	-	-	-	-	-	-	-	2a.
5	15	9	+	+	+	-	+	-	-	+	+	8a.
6	13	8	+	+	-	-	+	-	-	+	-	4b.
7	10	7	+	-	+	-	+	+	-	-	-	4c.
8	10	7	+	+	+	-	+	+	-	+	-	6b.
9	14	6	+	+	+	-	-	-	-	+	-	4d.
10	10	6	+	-	-	-	-	-	-	-	-	1a.

The type of streptococcus most frequently found to the extent of at least 10,000,000 *per cc. of saliva.*

In the case of 20 of the 22 samples examined, a dilution containing one ten millionth of a cc. of saliva was inoculated into neutral red broth subsequently incubated at 37° C. for 48 hours under anaerobic conditions. In the case of two of the samples no growth developed from this dilution of saliva, but in all the others streptococci were found present. The streptococcus present in the neutral red broth was in each of these 18 instances isolated in pure culture and subjected to the nine tests with the following result. Of type 5a eight specimens were obtained, of 4a five, of 2a two, of 4b one, of 3b one, and of 5h one. The two types found to occur most frequently in saliva to the extent of at least

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were, therefore, identical with the 2 types found to occur more frequently than any of the other 48 types of streptococci. It will be remembered that the 300 streptococci differentiated by the nine tests into these 48 types must all have been present to the extent of at least 100,000 per cc. of the samples of saliva from they were originally obtained.

The morphology in broth of the streptococci referred to one or other of the 48 types.

The morphology in broth of each streptococcus was observed at the time when it was first isolated, and the micro-organism was referred to one or other of the types Longus, Medius, Brevis, or Conglomeratus. By far the majority of the 300 streptococci were of the Brevis type in broth, and almost exclusively so in the case of the two most prevalent types 4a and 5a. As regards the other morphological types, I have not yet been able to persistently associate them with definite biological types defined by the nine tests.

TABLE.

Showing 48 Types of Streptococci isolated from 22 samples of normal saliva.

Groups.	Saccharose.	Lactose.	Raffinose.	Inulin.	Salicin.	Conferin.	Mannite.	Clot.	Neutral Red.	Number of specimens.	Number of sources.	Type co-efficient.
Group 1	+	+	+	−	+	−	−	−	−	10	6	1a
Group 2 ..	+	+	−	+	+	+	−	−	+	16	9	2a
	+	−	+	−	+	+	−	−	+	3	3	2b
	+	+	+	−	+	+	−	−	−	3	2	2c
	+	−	−	−	−	−	−	−	+	2	2	2d
Group 3 ..	+	+	−	−	−	−	−	+	−	24	15	3a
	+	+	−	+	+	+	−	−	+	5	5	3b
	+	+	+	−	−	−	−	−	+	5	5	3c
	+	+	+	−	+	+	−	−	−	4	3	3d
	+	+	−	−	+	−	−	−	+	3	3	3e
	+	+	+	−	+	−	−	−	+	2	2	3f
	+	+	−	−	+	−	−	−	+	2	2	3g
	+	−	+	−	−	−	−	−	+	1	1	3h
	+	−	−	+	+	−	−	−	−	1	1	3i

TABLE—*continued.*

Groups.	Saccharose.	Lactose.	Raffinose.	Inulin.	Salicin.	Coniferin.	Mannite.	Clot.	Neutral Red.	Number of specimens.	Number of sources.	Type co-efficient.
Group 4 ..	+	+	-	-	-	-	-	+	+	41	18	4a
	+	+	-	-	+	-	-	+	-	13	8	4b
	+	-	+	-	+	+	-	-	-	10	7	4c
	+	+	+	-	-	-	-	+	-	14	6	4d
	+	+	-	-	+	-	-	-	+	3	3	4e
	+	+	+	-	-	-	-	-	+	2	2	4f
	+	+	-	+	-	-	-	+	-	2	2	4g
	+	+	-	-	+	+	-	-	-	1	1	4h
	+	+	+	-	+	-	-	-	-	1	1	4i
	+	-	+	+	+	-	-	-	-	1	1	4j
	+	-	-	-	+	+	-	-	+	1	1	4k
	+	-	-	+	+	-	-	-	+	1	1	4l
Group 5 ..	+	+	+	-	-	-	-	+	+	43	17	5a
	+	+	+	+	-	-	-	+	-	7	4	5b
	+	+	-	-	+	-	-	+	+	5	4	5c
	+	+	-	+	+	-	-	+	-	4	4	5d
	+	+	+	-	+	-	-	-	+	4	3	5e
	+	-	+	-	+	+	-	-	+	4	3	5f
	+	+	-	+	-	-	-	+	+	3	3	5g
	+	+	+	-	+	-	-	+	-	3	2	5h
	+	+	-	-	+	+	-	+	-	3	2	5i
	+	-	+	+	+	+	-	-	-	2	2	5j
	+	+	+	+	-	-	-	-	+	2	1	5k
	+	+	-	-	+	+	-	-	+	1	1	5l
Group 6 ..	+	+	+	-	+	-	-	+	+	15	9	6a
	+	+	+	-	+	+	-	+	-	10	7	6b
	+	+	-	-	+	+	-	+	+	3	3	6c
	+	+	-	+	+	-	-	+	+	3	3	6d
	+	+	-	+	+	+	-	+	-	2	2	6e
	+	+	+	+	-	-	-	+	+	1	1	6f
Group 7 ..	+	+	+	-	+	+	-	+	+	5	5	7a
	+	+	+	+	+	+	-	+	-	4	3	7b
	+	+	+	+	+	-	-	+	+	2	2	7c
Group 8	+	+	+	+	+	+	-	+	+	3	2	8a

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Brief Summary.

From 22 samples of saliva, 300 streptococci have been isolated and subjected to the nine tests that are in question. Each streptococcus examined must have been present to the extent of at least 100,000 per cc. of saliva. All 300 streptococci had the following characters in common—a positive reaction in the saccharose test and a negative reaction in the mannite test. They differed so much in the remaining seven tests that they were broken up into no less than 48 different types. The majority of these types were found to occur comparatively rarely in saliva. On the other hand two of the types, namely 4a and 5a, were found to be commonly present in saliva. These two types possessed four positive characters in common and differed only as regards one test. The three positive characters of the type third in point of frequency were also possessed by the two preceding streptococci.

Over one third of the 300 streptococci belonged to these three types.

These particulars may be held, I believe, to be true for streptococci of normal human saliva in general. I have little doubt that types 4a and 5a are always present in saliva, and would have been found in all the samples had they been specially searched for.

Part II.—Streptococci Isolated from the Human Body in Disease.

1.—*Streptococci from a sample of pneumonic sputum.*

This sample of sputum had been sent to Dr. Klein for investigation as to the presence therein of B. pestis; but the result was negative. Microscopically, capsulated diplococci were seen to be present in large numbers. A surface agar plate yielded colonies of pneumococci, streptococci, and staphylococci. A guinea-pig injected intraperitoneally with some of the crude sputum was dead in 48 hours, and its peritoneal fluid was found to be crowded with two different micro-organisms, namely, pneumococci and streptococci. Dr. Klein very kindly gave me the opportunity of examining the streptococci present, both in the peritoneal exudation of the guinea-pig and in the agar plate made by him from the sputum.

From the peritoneal exudation an agar plate was made, and a pure sub-culture of the steptococcus obtained from a single colony. Its characters were found to be as follows. Morphologically in broth the streptococcus presented the usual appearance of S. pyogenes, the fluid remaining clear and a collection of white flocculi, composed of chains medium in length, forming at the bottom of the tube. On subjecting the streptocuccus to the nine *tests* a positive reaction was obtained only in the case of two, *namely*, in saccharose and lactose. When injected subcutaneously

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into a mouse the streptococcus produced death in 48 hours, and was recovered in pure culture from the animal's spleen.

From the agar plate made from the sputum six colonies that appeared to be representative of various streptococcus colonies present were subcultured. Each streptococcus was then injected into a mouse. Five of these mice were unaffected; the sixth died within 48 hours of injection, and yielded a pure culture of the streptococcus with which it had been injected. This streptococcus had the following characters: broth was rendered uniformly turbid, and microscopically the appearance was indistinguishable from that of ordinary S. brevis of saliva. On applying the nine tests, a positive reaction was obtained in the case of five of them, namely, in saccharose, lactose, raffinose, clot, and neutral red. This streptococcus, therefore, gave reactions to the tests identical with those given by one of the commonest types of streptococcus found in saliva, namely, type 5a. But it was in addition possessed of high virulence for the mouse.

In this sample of pneumonic sputum, therefore, the following pathogenic micro-organisms were detected :—

(1) Virulent pneumococci.

(2) A virulent streptococcus of the S. pyogenes type.

(3) A streptococcus giving the reactions of one of the commonest types of S. brevis of saliva, but, unlike that micro-organism, manifesting virulence for the mouse.

2. *Streptococci isolated from various Septic and Septicæmic Processes, in none of which was there question of Scarlet Fever.*

Altogether 10 streptococci of this category have been examined, and for almost all of them I am indebted to Dr. Andrewes. By the nine tests these 10 streptococci have been differentiated into the six following types :—

Type 1.—The only example obtained of this type was one of the 10 streptococci mentioned previously as having been tried against various organic substances. Of the nine selected tests, only two, namely, lactose and mannite, were reacted to in a positive manner by this streptococcus. It was originally isolated from pus of an abscess caused by a splinter of wood. The question of the virulence of the streptococcus for a mouse was not examined until it had been in culture for some time, and was then found to be negative.

Type 2.—Streptococci of this type also reacted in a positive manner to only two of the nine tests, namely, to saccharose and lactose. Four specimens of the type were isolated from the following sources :—

1. Heart's blood of a patient who had succumbed during an attack of pleurisy.

2. Pleural effusion of a fatal case of pleurisy.

3. Heart's blood of a child, dead a few days after receiving injuries from burning.

4. Heart's blood of a patient who had succumbed during an attack of erysipelas and cellulitis.

All these streptococci had been obtained from their sources in pure culture. The first of the four streptococci mentioned was one of the ten tried against various organic substances. A fifth example was one of the streptococci obtained from the sample of pneumonic sputum previously described. Counting that specimen, four examples have been injected into mice. All produced death; two in two days, one in three days, and one in 11 days.

Type 3.—The third type of streptococcus reacted in a positive manner to three of the nine tests, namely, to saccharose, lactose, and salicin. Two specimens of it have up to the present been obtained. One was isolated from the pus of a submental abscess, the other from the wound and also from the blood of a case of septicæmia. Both killed mice within two days of injection.

Type 4.—This type of streptococcus also reacted in a positive manner to three of the nine tests, which were saccharose, lactose, and mannite. The streptococcus was obtained in pure culture from the heart's blood of a patient who had succumbed to what appeared clinically to be an attack of pure erysipelas. A mouse injected subcutaneously with the streptococcus succumbed in four days.

Type 5.—This type reacted positively to four of the nine tests, namely, to saccharose, lactose, salicin, and mannite. One specimen of the type was obtained, and it came from a pleural effusion. A mouse injected with the streptococcus succumbed in four days.

Type 6.—This type reacted positively to five of the nine tests, namely, to saccharose, lactose, salicin, coniferin, and clot. One specimen of it was obtained, and it was isolated from the pus of an empyema. A mouse injected with this streptococcus remained unaffected.

3.—*Streptococci isolated from Septic Processes associated with an attack of scarlet fever.*

1. The first streptococcus of this category was obtained both from the wound and from the pharyngeal mucus of a nurse whose illness developed shortly after receiving an injury in the hand from a pointed instrument. The wound suppurated, and at first disease was limited to the hand and forearm. Later, however, a rash and sore-throat developed, and the case was from the clinical symptoms diagnosed as one of scarlet fever. The bacteriological examination of material from this source was made on the day that the rash and sore-throat first appeared. The isolation of the streptococcus from the wound was a simple matter staphylococcus aureus being the only other micro-organism present. In the case of the throat, measured dilutions of the pharyngeal mucus

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were made, and a series of cultures on agar and serum inoculated therefrom. These cultures were examined for S. scarlatinae with negative result. A mouse was then injected with the total growth of a 48 hours' serum culture that had been made from $\frac{1}{250.000}$ cc. of the patient's tonsillar mucus. The mouse died in three days, and from its heart's blood and spleen a pure culture was obtained of a streptococcus. The two streptococci obtained respectively from the wound of the patient by culture, and from the throat by injecting a mouse, gave identical reactions to the nine tests. In both cases three reactions were positive, namely, those in saccharose, lactose, and salicin. The type present was thus identical in reactions with type 3 of the streptococci isolated from septic processes to which no suspicion of scarlet fever attached. It should be added that the streptococcus obtained from the wound of the patient killed a mouse in 48 hours.

2. The second specimen of streptococcus obtained from a septic process associated with an attack of scarlet fever was isolated from the ear discharge of a patient suffering from undoubted scarlet fever. Dr. A. E. Thomas kindly sent this specimen to me. The streptococcus gave a positive reaction to three of the nine tests, namely, to saccharose, lactose, and salicin. According to these tests, therefore, the streptococcus belonged to the same type as the streptococcus obtained from the preceding case.

3. The third streptococcus was isolated from pus on the surface of the tonsil and also from the interior of an enlarged cervical gland of a fatal case of scarlet fever. Dr. Foord Caiger kindly gave me the opportunity of examining this case post-mortem. Both on the surface of the tonsil and in the interior of the cervical gland the streptococcus was associated with virulent pneumococci. No growth was obtained from the patient's heart's blood or spleen. Both the streptococcus from the cervical gland and that from the tonsil behaved in identical fashion to the nine tests; in four of which reactions were positive, namely, saccharose, lactose, salicin, and mannite. According to the response to the nine tests, therefore, the streptococci were both examples of type 5 of the streptococci isolated from non-scarlatinal septic processes. It should be added that the streptococcus from the tonsillar pus killed a mouse in four days, and that the streptococcus from the cervical gland produced the same result in eight days.

So far, therefore, streptococci isolated from septic processes developing during an attack of scarlet fever and submitted to the nine tests, have not been distinguished by these tests from types of streptococci previously found to occur in septic processes in which there was no question of scarlet fever. These results are in accordance with views expressed in my last report on the bacteriology of scarlet fever.

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Characters by which Streptococci and Staphylococci may be differentiated and identified, by Dr. Gordon.

TABLE.

Showing the Characters of Streptococci isolated from various "Septic Processes."

Number.	Sources.	Specimens.	Saccharose.	Lactose.	Raffinose.	Inulin.	Salicin.	Coulterin.	Mannite.	Clot.	N. red.	Pathogenicity.
1	Pus of abscess	1	−	+	−	−	−	−	+	−	−	Not tested.
2	1. Blood, pleurisy 2. Blood, burns .. . 3. Blood, cellulitis and erysipelas. 4. Pleural effusion ..	4	+	+	−	−	−	−	−	−	−	3 tested and all found pathogenic for mouse.
3	1. Pus of abscess .. 2. Wound and blood of case of septicæmia. 3. Wound and throat of ? surgical scarlet fever. 4. Pus, otorrhœa, S.F. ..	4	+	+	−	−	+	−	−	−	−	3 tested and all found pathogenic for mouse.
4	Blood, erysipelas ..	1	+	+	−	−	−	−	+	−	−	Pathogenic for mouse.
5	1. Pleural effusion .. 2. Tonsil and cervical gland, scarlet fever.	2	+	+	−	−	+	−	+	−	−	Both found pathogenic for mouse.
6	Pus of empyema ..	1	+	+	−	−	+	+	−	+	−	Mouse unaffected.

4.—*Streptococci isolated from cases of Ulcerative Endocarditis.*

Five streptococci, each isolated from a different case of ulcerative endocarditis, have been examined. For three of these specimens I am indebted to Dr. Andrewes, and for two of them to Dr. Horder. The streptococci given me by Dr. Andrewes had each been obtained, after the death of the patient, by means of a culture from a valve of the heart. On the other hand, both Dr. Horder's specimens were cultivated by him from blood drawn off during life.

The reactions given by these five streptococci to the nine tests are recorded in the accompanying table, and are of considerable interest. In the first place they demonstrate in definite and tangible form the difference of character that exists between the streptococci of ulcerative endocarditis, and streptococci isolated from other kinds of septicæmia and subjected to the nine tests. This difference of character is especially noteworthy in regard to the positive response given by the streptococci of ulcerative endocarditis to the raffinose, clot, and neutral red tests. The

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point of chief interest, however, with regard to these streptococci is not so much one of differentiation as of identification. From their reactions to the nine tests, all five streptococci of ulcerative endocarditis could be identified with types of streptococci previously found to occur in saliva; and—what is more striking still—two of the streptococci gave reactions identical with those of the two streptococci previously found to occur more constantly and more abundantly than any other micro-organism in normal human saliva.

Both the streptococci identified from their reactions to the tests with the two commonest types of salivary streptococci were obtained by Dr. Horder from the blood of patients during life. To one of these cases a special interest attaches because of the exceptionally elaborate efforts made to save the patient's life. These efforts were unfortunately unsuccessful, although, amongst other things, all the antistreptococci sera on the market were tried, and, in addition, specially prepared sera, obtained from two animals immunised against the particular streptococcus obtained from the patient's blood, were freely used.* The streptococcus in question was identical in its reactions with streptococcus 5a of saliva, but, unlike that micro-organism, possessed high virulence for the mouse. A mouse injected with the streptococcus recently isolated from the blood of the patient, died within 48 hours. The micro-organism was recovered in pure culture from the animal's spleen and was injected into another mouse, which also succumbed in 48 hours. The virulence in this instance is the more remarkable because it is unusual in my experience to obtain a lethal effect on a mouse with streptococci from cases of ulcerative endocarditis. Two of the other four streptococci in the present series were injected into mice but with no result; and this is what has occurred on a number of previous occasions when I have examined the virulence for mice of streptococci isolated from cases of ulcerative endocarditis. Their inferior virulence for mice is in keeping with such streptococci having been derived from the mouth.

Table.

Showing Characters of Streptococci isolated from cases of Ulcerative Endocarditis.

Case.	Source	Saccharose.	Lactose.	Raffinose.	Inulin.	Salicin.	Coniferin.	Mannite.	Clot.	N. Red.	Salivary co-efficient	Pathogenicity.
1	Blood during life..	+	+	-	-	-	-	-	+	+	4a	—
2	Blood during life..	+	+	+	-	-	-	-	+	+	5a	Mouse died in two days.
3	Heart valve, P.-M.	+	+	+	-	+	+	-	+	-	6b	Mouse unaffected.
4	Heart valve, P.-M.	+	+	+	-	+	+	-	+	+	7a	Mouse unaffected.
5	Heart valve, P.-M.	+	+	+	-	+	+	-	+	+	7a	—

* This case is reported by Dr. Horder in the "Lancet," July 16th, 1904.

haracters by hich Strepto- occi and taphylococci ay be ifferentiated d identified : Dr. Gordon.

SUMMARY.

The application of the nine tests to streptococci isolated from the human body in disease has shown that among these streptococci a number of different types are distinguishable. Twenty streptococci submitted to the tests have been differentiated into no less than ten types.

I. *Streptococci of sepsis.*—Among 13 streptococci isolated from various septic and septicæmic processes six different types were distinguished. The types found commonest were those giving positive reactions to saccharose and lactose alone, or positive to the same two tests with the addition of a positive reaction to salicin. It is noteworthy, however, that no less than three of the types of streptococci from this class of disease produced a positive reaction to the mannite test. On the other hand, none of the streptococci isolated from septic processes produced a positive reaction to raffinose or to neutral red, and of the six types obtained, five failed to change coniferin or to clot milk.

2. *Streptococci of Ulcerative Endocarditis.*—Five streptococci, isolated from cases of ulcerative endocarditis, were differentiated by the tests into four types. All of these types clotted milk, and three of them produced a positive reaction in regard to raffinose and neutral red. Two of the types also gave a positive reaction in coniferin. On the other hand, all these streptococci were negative to mannite.

It is noteworthy that none of the streptococci, either from septic processes or from cases of ulcerative endocarditis, produced a positive reaction in respect of inulin.

As a class, the types of streptococci isolated from septic and septicæmic processes were found to be more virulent to mice than those obtained from cases of ulcerative endocarditis.

3. *The relationship of streptococci of normal human saliva to those isolated from the human body in disease.*—On comparing the reactions of streptococci isolated in disease with those of streptococci occurring in normal saliva the following four points can already be discerned :—

1. The types found to occur most frequently in normal saliva were those denoted 4a and 5a, of which 4a was positive to saccharose, lactose and neutral red, while 5a was positive to the same tests and also to raffinose. The type of streptococcus fourth in frequency was 2a, which was only positive to saccharose and lactose. Examples of these three types from normal saliva have been tested and found to be devoid of virulence for the mouse.

2. In a sample of pneumonic sputum, in addition to the pneumococcus, two types of streptococci were found to possess virulence

for the mouse. These virulent streptococci gave with the nine tests the reactions of types 4a and 2a respectively.

3. One of the virulent streptococci found to occur most frequently in septic processes gave the reactions of 2a.

4. Two streptococci isolated from patients suffering from ulcerative endocarditis gave reactions identical with those of 4a and 5a. The latter of the two was found to possess virulence for the mouse.

The above facts suggest that the streptococci of normal saliva are of considerable interest from the point of view both of surgery and of medicine.

PART III.—THE EFFECT OF PASSING A STREPTOCOCCUS THROUGH AN ANIMAL ON ITS BEHAVIOUR TO THE NINE TESTS.

This question has been determined in the case of 11 streptococci, distinguished by the nine tests, into six different types. All these streptococci were injected subcutaneously and recovered from the spleens of their respective mice. Particulars and results are as follows :—

Type 1.—A positive reaction given to two only of the nine tests, namely, to saccharose and lactose.

Two specimens of this type have been examined, both before and after passage through a mouse. The first specimen —isolated from the sample of pneumonic sputum—was found to be unaltered ; the second—isolated from a pleural effusion —was, on recovery from the mouse, found to produce an additional positive reaction in salicin. This additional reaction was feeble, but clear.

Type 2.—A positive reaction given to three of the tests, namely, to saccharose, lactose, and salicin.

Three specimens of this type were examined. They had been isolated from three different cases, namely, from the blood of a case of septicæmia, from pus obtained from an abscess, and from pus of a wound. All three streptococci, after passage through the mouse, maintained their reactions, both positive and negative, unaltered.

Type 3.—A positive reaction given to three of the tests, namely, to saccharose, lactose, and mannite.

The single specimen of this type tested was obtained in pure culture from the heart's blood of a fatal case of erysipelas. On recovery from the mouse the reactions of the streptococcus were found to be unaltered.

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Type 4.—A positive reaction given to four of the tests, namely, to saccharose, lactose, salicin, and mannite.

Two specimens of this type were examined; one isolated from a pleural effusion in a fatal case of pleurisy, the other from the tonsil and cervical gland of a fatal case of scarlet fever. Both streptococci after passage through the mouse maintained their reactions unaltered.

Type 5.—A positive reaction given to five of the tests, namely, to saccharose, lactose, raffinose, clot, and neutral red.

Two specimens of this type were examined. The first was isolated from the sample of pneumonic sputum previously referred to, and on recovery from the mouse was found to maintain its reactions unaltered. The second specimen came from the blood of a case of ulcerative endocarditis, and on recovery from the mouse was found to have lost one of its positive reactions, namely, the reaction in neutral red. The streptococcus was now passed through a further mouse, and re-examined. It was found to give the same reactions as after passage through the first mouse, and was still negative in neutral red.

Type 6.—A specimen of the air streptococcus. A positive reaction to three of the tests, namely, to saccharose, salicin, and coniferin.

This streptococcus was present in broth culture, which also contained B. enteritidis sporogenes. A guinea-pig subcutaneously injected with the broth containing these two micro-organisms died in 48 hours from the action, chiefly, of the anaerobic bacillus. The streptococcus was easily recovered by aerobic agar cultures, both from the subcutaneous fluid and from the heart's blood. As recovered from both of these sources, it was retested and found to give the same reactions to the tests as before.

Summary.

Nine of the eleven streptococci, including individuals from all six types examined, were found, after passage through the mouse, to be unaltered as regards their reactions to the nine tests.

In two instances only was an alteration found to have taken place. One streptococcus had gained positive reaction for salicin, the other had lost its positive reaction for neutral red.

Conclusion.

Seven of the nine reaction tests appear to be trustworthy indices of the attributes of streptococci of one or another type; of attributes which there is no evidence at the present time for considering as otherwise than stable. This being so, the

value of these seven tests for differentiating various kinds of streptococci is likely to be permanent. The exact value in each instance and in this sense of the other two tests, namely, salicin, and neutral red, has still to be adequately determined. The present indications are, in my opinion, very decidedly in favour of retaining them as routine tests for streptococci.

PART IV.—STREPTOCOCCI ISOLATED FROM DIVERSE SOURCES.

1. *A streptococcus isolated from a typhoid stool.*—This micro-organism was one of the 10 tried against various organic substances. It gave a positive reaction to seven of the nine tests. The only two of the tests in which it gave negative reactions were raffinose and inulin. This streptococcus also gave positive reactions in some of the tests not applied as a matter of routine. These extra tests to which it was positive were rhamnose, glycerin, and sorbit. The streptococcus failed to liquefy gelatine.

2. *A streptococcus sent me by Dr. Savage, who isolated it from horse manure.*—This micro-organism gave positive reactions in five of the nine tests, namely, in saccharose, raffinose, inulin, salicin, and coniferin. The type as defined by the tests, therefore, was identical with a type found rarely in saliva. The salivary type referred to was 5j, of which two specimens were obtained, each from a different sample of saliva.

3. *A streptococcus isolated from the liquor of an oyster.*—This was one of the 10 streptococci tried against various organic substances, and it gave five positive reactions in the nine selected tests, namely, as regards lactose, salicin, coniferin, mannite, and clot. In the extra tests, rhamnose, glycerin, and sorbit, it gave negative reactions.

4. *Streptococci isolated from milk.*—A. This streptococcus came from a sample of milk not definitely implicated in production of illness amongst consumers. The micro-organism was one of the 10 streptococci tried against various organic substances. In the nine selected tests it gave four positive reactions, namely, as regards saccharose, lactose, salicin, and clot. To the extra tests it gave a negative response. When first isolated from milk this streptococcus was tested and found not to possess virulence for the mouse. From its reactions it will be seen that this micro-organism was identified with the type of streptococcus 6th in frequency in saliva. The salivary type referred to is 4b, altogether 13 specimens of which were obtained from eight different samples of saliva.

B. The next streptococcus was obtained from a sample of milk, definitely associated with an epidemic of "throat illness" amongst consumers. The sample was kindly given me by Dr. Pierce, of Guildford, and contained much pus. It had been kept in a glass-stoppered bottle for some considerable time before examination. Microscopically, streptococci were seen to be present in large numbers. Four mice were kept without food for

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a day and then fed with the material. One of these mice succumbed within four days, and it was from the heart's blood and spleen of this mouse that the present streptococcus was recovered in pure culture.

The streptococcus in question reacted to three of the nine tests in a positive manner; that is to say, it was positive as regards saccharose, lactose, and salicin. It was identified, therefore, with one of the commonest types recovered from septic processes and which has been described previously.

5. *Streptococci isolated from dust.*—A. This streptococcus was obtained from a sample of dust taken from the interior of a railway carriage. On examining its reactions to the nine tests it was found to give only one positive reaction. The single test to which it was positive was mannite.

B. A streptococcus isolated from a sample of dust collected off the laboratory floor. It was one of the 10 streptococci tried against organic substances. Seven of the nine tests were responded to in a positive fashion by this streptococcus; as regards two it was negative—raffinose and inulin. In the extra tests of rhamnose, glycerin, and sorbit, the streptococcus gave positive reactions. The only difference I have been able to detect between this streptococcus and streptococcus No. 1 of the present series, is in regard to the liquefaction of gelatine. This is effected by the present streptococcus but not by No. 1 or by any of the rest.

C. This streptococcus, as also the next, were both isolated from $\frac{1}{1000}$ gramme of dust. The sample of dust from which these streptococci were obtained was procured by exposing paper beneath a grating immediately over which the soles of many persons' feet were passing at the time. The material, which had been carefully collected almost daily for two months, should represent a good average sample of boot-dust. The present streptococcus reacted to six of the nine tests in a positive fashion. The three tests to which it was negative were saccharose, raffinose, and inulin. This streptococcus also gave a negative reaction to glycerin.

D. The second streptococcus from the same source as the last reacted in a positive manner to seven of the nine tests. The two tests to which it was negative were raffinose and inulin. This streptococcus also gave a negative response to the glycerin test, a point that distinguishes it from streptococci 1 and 5b in the present series.

6. *Streptococci isolated from air.*—Up to the present I have distinguished three types of the air streptococcus by means of the nine tests. The reactions of these three types are as follows:—

A. Positive to two of the nine tests, namely, to saccharose and salicin.

B. Positive to salicin and coniferin.

C. Positive to saccharose, salicin, and coniferin.

An example of C. was one of the 10 streptococci tried against various organic substances. I am unable at present to definitely state which of these three types of the air streptococcus is commonest in air.

Summary.

The reactions given by the 12 streptococci of the present series are seen in the subjoined table. In contrast to streptococci of saliva it is noteworthy that four of the present series reacted in a negative fashion to saccharose; that only one of the 12 gave a positive reaction to raffinose; and that no less than six of them acted on mannite. Two of the latter streptococci also acted upon sorbite, glycerin, and rhamnose; and since both had responded to the other tests in the same way, they were only to be distinguished by the fact that one of them liquefied gelatine.

Table.

Showing Characters of 12 Streptococci from diverse sources.

No.	Source.	The Nine Routine Tests.									Extra Tests.		Remarks.
		Saccharose.	Lactose.	Raffinose.	Inulin.	Salicin	Conferin.	Mannite.	Clot.	N Red.	Glycerin.	Rhamnose.	
1	Typhoid stool ..	+	+	−	−	+	+	+	+	+	+	+	Sorbite test positive.
2	Horse manure ..	+	−	+	+	+	+	−	−	−			
3	Oyster	−	+	−	−	+	+	+	+	−	−	−	Sorbite test negative.
4a	Milk	+	+	−	−	+	−	−	+	−	−	−	Sorbite test negative.
4b	Purulent milk ..	+	+	−	−	+	−	−	−	−			Virulent for mouse
5a	Dust from railway carriage.	−	−	−	−	−	−	+	−	−			
5b	Dust of laboratory.	+	+	−	−	+	+	+	+	+	+	+	Rapidly liquefies gelatin. Sorbite test positive.
5c	Dust of boots ..	−	+	−	−	+	+	+	+	+	−		
5d	Ditto ..	+	+	−	−	+	+	+	+	+	−		
6a	Air	+	−	−	−	+	−		−	−			
6b	Ditto	−	−	−	−	+	+	−	−	−			
6c	Ditto	+	−	−	−	+	+	−	−	−			

SECTION IV.

The Differentiation of Staphylococci.

Particles of skin and scurf from six normal individuals were distributed in small quantities of sterile salt solution, and cultures were made therefrom on surface agar-plates and in neutral red broth. Both sets of cultures were then incubated at 37° C., the neutral red broths being placed under anærobic conditions. The micro-organisms that developed in greatest number from each of the several samples were staphylococci, and in each instance the staphylococcus present in greatest abundance belonged to the type of Staphylococcus albus.

Staphylococci are, as a class, distinguished from the two other chief classes of cocci by the direction in space in which their individuals divide. Streptococci divide solely in one direction, staphylococci in two, and sarcinæ in three. Another fundamental difference between staphylococci and streptococci is the fact that the growth of staphylococci on ordinary solid nutrient media, especially on agar at 37° C., is much more copious than that of streptococci, the colonies of the two being distinguishable at a glance. By reason of the pigmentation of their colonies, staphylococci admit of subdivision into three main types, according as the colour of these colonies is white or grey, yellow, and orange or golden. Since, in the present enquiry, staphylococci of the albus type are of chief interest, attention has been mainly, though not exclusively, confined to them.

Having found, therefore, that the chief micro-organisms present in cultures from particles of skin and scurf were staphylococci of the albus type, the next point to be determined was whether these staphylococci of skin and scurf respectively possessed characters by which they could be distinguished in the first place from each other, and, secondly, from staphylococci found elsewhere. It was clear that if such differentiation were found impracticable, search in any material for the presence of these micro-organisms with a view of detecting particles of skin and scurf could not usefully be made.

A comparison of the morphological and cultural characters of these and of other staphylococci albi on ordinary laboratory media was made, but it failed to satisfactorily decide the points at issue. Morphologically such minor differences as were observed did not appear to be of sufficient magnitude or sharpness for practical routine application. As was to be expected, all the staphylococci examined gave a positive reaction with Gram's stain, and all were non-motile. Of cultural tests at present generally in use for distinguishing staphylococci, the two that were found to be of most value were growth in litmus milk at 37° C., and on gelatine at 22° C. The physiological differences shown in these media were sharp and definite, having regard to acid production, clot, and peptonisation in litmus milk; and in the case of gelatine,

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liquefaction of the medium. But though valuable, the differences between them brought out by these two media alone were found insufficient for the purpose at present in view.

Accordingly a search for further tests by which staphylococci may be differentiated has been begun on similar lines to the investigation previously made in the case of streptococci. In the first place staphylococci have been compared in respect of their ability to produce acid reaction in litmus broth containing a given organic substance. The medium was prepared in the same way as when testing streptococci in a similar sense. Six selected staphylococci were tried in this manner against 20 different substances of the carbohydrate, glucoside, or polyatomic alcohol series. Secondly, the ability of the staphylococci to produce a change in the colour of neutral red broth has been examined; and thirdly their power to reduce nitrate to nitrite has been tested.

Five of the six staphylococci selected for trial in these tests belonged to the albus type; the sixth was an example of Staphylococcus pyogenes aureus. As regards the sources from which they were obtained, the first two specimens of albus were isolated from skin, the third from scurf, and the fourth and fifth from saliva. The specimens of Staphylococcus aureus came from pus.

When testing these six staphylococci against various organic substances in litmus broth, the cultures were incubated at 37° C. aërobically; but instead of incubation for three days as in the case of streptococci, contact was allowed for a week. This longer duration of the tests in the case of staphylococci appeared desirable because the production of an acid reaction by some staphylococci, though clear by the end of a week, may have been barely perceptible by the third day.

Results.

The 20 organic substances on which the action of the six staphylococci has been observed were a selection of those previously used when searching for tests whereby to differentiate streptococci. The results of the tests are recorded in the accompanying table. Four of the 20 substances, namely, lactose, maltose, glycerin, and mannite, were found to be applicable for bringing out differences between staphylococci. The neutral red broth test was next examined and found to be of differential value. Lastly, the staphylococci were cultivated in nitrate broth at 37° C., and the cultures tested on the third day for nitrite. It will be remembered that streptococci when tested in this medium failed to reduce the nitrate. It was a striking difference, therefore, to find that each of the six staphylococci under review gave a strong positive reaction in this sense. Although the six staphylococci all reacted in the same positive manner, further unquestionable staphylococci that were tested in nitrate broth in the same way gave, in some instances, a negative reaction. The nitrate test, therefore, is of value for differentiating staphylococci.

ART. II, No. 4.—Characters by which Streptococci and Staphylococci may be differentiated and identified: by Dr. Gordon.

No.	Source.	Colour.	Carbohydrates.												Glucosides.		Polyatomic Alcohols.					
			Rhamnose.	Glucose.	Fructose.	Mannose.	Galactose	Saccharose.	Lactose.	Maltose.	Raffinose.	Starch.	Inulin.	Dextrin.	Salicin.	Coniferin.	Glycol.	Glycerin.	Erythrit.	Dulcite.	Sorbite.	Mannite.
1.	.. ..	Skin	Albus.. ..	-	+	+	+	+	+	+	+	-	-	-	-	-	-	-	+	-	-	-
2.	.. ..	Skin	Albus.. ..	-	+	+	+	+	+	-	+	-	-	-	-	-	-	-	+	-	-	-
3.	.. ..	Scurf	Albus.. ..	-	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	.. ..	Saliva ..	Albus.. ..	-	+	+	+	+	+	+	+	-	-	-	-	-	-	-	+	-	-	-
5.	.. ..	Saliva ..	Albus.. ..	-	+	+	+	+	+		+	-	-	-	-	-	-	-	-	-	-	-
6.	.. ..	Pus	Aureus ..	-	+	+	+	+	+	+	+	-	-	-	-	-	-	-	+	-	-	+

+ Indicates that a distinct acid reaction was produced by the staphylococcus under the conditions of experiment.

Characters by which Streptococci and Staphylococci may be differentiated and identified by Dr. Gordon

Actions in respect of which staphylococci as a class contrast strongly with streptococci.

Besides the great difference between the two classes of cocci brought out by the nitrate test, other points of divergence are conspicuous. One of these is the fact that none of the staphylococci produced an acid reaction when growing in the presence of the glucosides, salicin and coniferin. Another point calling for remark is in regard to the action of the two classes of cocci on the triatomic alcohol glycerin, and the hexatomic alcohol mannite, respectively. Whereas streptococci appear to act on mannite more easily than on glycerin, the opposite seems to be true for many staphylococci. Other points of divergence are seen in the matter of the liquefaction of gelatine, peptonisation of milk, &c.

At this stage therefore of the investigation no less than nine tests were available for ascertaining differences between the characters of various staphylococci. These tests are as follows :—

1. The question of the positive liquefaction of gelatine (12 per cent.) during a week at 22° C.

2. The clotting of litmus-milk in the same time at 37° C.

3. The peptonisation of the milk in the same time.

4. The reduction of nitrate to nitrite. This test is applied after three days at 37° C.

5. The production of a change in the colour of neutral red broth in the course of two days anaërobically at 27° C.

6. The production during a week at 37° C. of an acid reaction in slightly alkaline litmus broth containing 1 per cent. of lactose.

7. Similar conditions, but with maltose.

8. Similar conditions, but with glycerin.

9. Similar conditions, but with mannite.

Accordingly in all these nine tests, contact was allowed for a week, except in the case of the neutral red and nitrate tests, the results of which were recorded after 48 hours and after 72 hours respectively.

The reactions of the six staphylococci to the nine tests are summarised in the following table :—

No.	Type.	Source.	Liquefaction of Gelatine.	Clot.	Peptonisation. (Adams Milk).	Nitrate reduced to Nitrite.	Neutral Red.	Maltose.	Lactose.	Glycerin.	Mannite.
1.	Albus	Skin	+	+	-	+	+	+	+	+	-
2.	Do.	Do.	+	-	-	+	+	+	-	+	-
3.	Do.	Scurf	-	-	-	+	-	-	-	-	-
4.	Do.	Saliva	+	+	+	+	+	+	+	+	-
5.	Do.	Do.	-	-	-	+	-	+	-	-	-
6.	Aureus	Pus	+	+	-	+	-	+	+	+	+

The sign + signifies a positive response to the test under the conditions described.

The reactions of the six staphylococci to the nine tests were tested again on two subsequent occasions, with the same result as in the first instance.

One of two alternative procedures was now possible. Either search could be continued for other characters in which staphylococci exhibit differences *inter se*, or a series of staphylococci could be submitted to the nine differential tests already available. Having regard to the special object in view in the present instance it was decided to adopt the latter course, at any rate as a preliminary procedure.

Accordingly 50 staphylococci have been isolated from various sources, chiefly up to the present from saliva, and submitted to the nine tests. The results are as follows :—

Staphylococci, the colonies of which are White or Grey.

Sources.—Forty-one staphylococci of this type have been examined from the following sources. Twenty-eight of the staphylococci were isolated from various samples of saliva. Each of these micro-organisms had been present to the extent of at least 100,000 per cc. of saliva. Of the remaining staphylococci two were isolated from skin, two from scurf, one from urine, one from purulent sputum, one from empyema pus, and one from the contents of a boil. Five specimens were isolated from the air of a public meeting-room shortly after the audience had left.

Groups.—According to the number of positive reactions given by them to the nine tests, these 41 staphylococci can be referred to one or other of eight groups. The number of specimens examined is not sufficiently large as yet to justify any definite conclusion as to the strength numerically of the various groups.

Characters by which Streptococci and Staphylococci may be differentiated and identified by Dr. Gordon

It will be seen, however, from the table that up to the present more specimens are included in the middle groups, four and five, than in the first and last groups.

Types.—Dealing next with the question of types it appears that the 41 staphylococci have been differentiated by the tests into 23 different types. Most of these types are exemplified by but few specimens. Thus :—

15 types possess only a single specimen.
4 „ „ 2 specimens.
1 „ „ 3 „
2 „ „ 4 „
1 „ „ 7 „

Characters of the types of Staphylococcus albus most frequently found.

1. The seven specimens of the type of Staphylococcus albus found most frequently were all obtained from saliva, and were isolated from six different samples. The four positive reactions given by this staphylococcus were, with regard to liquefaction, nitrite, maltose, and glycerine respectively.

2. The type next in frequency has also, up to the present, only been obtained from saliva. Four specimens of it were isolated from four different samples. This staphylococcus only gave a positive reaction to one of the nine tests, namely, to maltose.

3. The type third in frequency was also only isolated from saliva. Four specimens of it were obtained from two samples. This staphylococcus gave a positive reaction to three of the nine tests, namely, to the liquefaction test, nitrite, and maltose.

With regard to the other types, it will be noticed that the staphylococci isolated from skin and scurf respectively, are distinct from one another, as also from the other staphylococci with which comparison has up to the present time been made. It will be necessary, however, to make a large number of further observations before definite conclusions can be drawn as to the serviceability of these facts for the special object in view in the present instance.

As regards the staphylococci of other than albus type which have been examined, it will be seen that three specimens of staphylococci that exhibited yellow colonies were differentiated by the nine tests into three different types. The six specimens of Staphylococcus aureus examined were distinguished by the same means into two types, which only differed in regard to one test, namely, neutral red.

The example of Sarcina lutea examined for comparison with staphylococci gave two positive reactions in the nine tests, namely, liquefaction of gelatine and peptonisation of milk. An alkaline reaction was produced in the litmus milk by this sarcina.

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TABLE.

Showing the Characters of various Staphylococci.

Colour of growth on agar, 37° C.	Group.	Liquefaction.	Clot.	Peptonisation.	Nitrite.	Neutral Red.	Maltose.	Lactose.	Glycerin.	Mannite.	Number of Specimens.	Source.
White or grey ..	I. ..	−	−	−	+	−	−	−	−	−	2	Scurf.
		−	−	−	−	−	+	−	−	−	4	Saliva.
" " ..	II. ..	−	−	−	+	−	+	−	−	−	3	"
		−	−	−	−	−	+	−	+	−	1	"
		+	−	−	−	−	+	−	−	−	1	"
" " ..	III. ..	+	−	−	+	−	+	−	−	−	4	"
		−	−	−	+	+	+	−	−	−	1	"
		−	−	−	−	−	+	+	+	−	1	Air.
" " ..	IV. ..	+	−	−	+	−	+	−	+	−	7	Saliva.
		−	−	−	+	−	+	+	−	+	1	Urine.
" " ..	V. ..	+	−	−	+	+	+	−	+	−	3	Saliva.
		+	−	−	+	−	+	−	+	+	1	"
		+	−	−	+	+	+	+	−	−	1	"
		−	+	−	+	−	+	+	+	−	1	Boil.
		−	+	−	+	+	+	+	−	−	1	Air.
		−	−	−	−	+	+	+	+	+	1	"
" " .	VI ..	−	+	+	+	−	+	+	+	−	1	Empyema pus.
		−	+	−	+	+	+	+	+	−	1	Skin.
		+	+	−	+	+	+	−	+	−	1	"
" " ..	VII. ..	+	+	−	+	+	+	+	+	−	2	Saliva; air.
		+	+	+	+	−	+	+	+	−	2	" "
		+	+	−	+	−	+	+	+	+	1	Purulent sputum.
" " ..	VIII. ..	+	+	+	+	+	+	+	+	−	1	Saliva.
Yellow	.. ..	+	−	−	+	−	+	−	+	−	1	Saliva.
		+	−	−	−	−	−	+	+	+	1	"
		+	+	+	−	+	+	+	+	−	1	"
Golden	.. ..	+	+	−	+	+	+	+	+	+	4	Pus; air.
		+	+	−	+	−	+	+	+	+	2	" "
Lemon Yellow ..	Sarcina lutea.	+	?	+	−	−	−	−	−	−	1	Air.

SECTION V.

Characters by which Streptococci and Staphylococci may be differentiated and identified by Dr. Gordo

General Conclusions.

Comparison between the characters of various streptococci has revealed differences, not merely of degree but of kind, and has proved that differentiation obtains in the streptococcus group to an extent previously unknown.

The result of a scrutiny of 300 streptococci of saliva in respect of their reaction to nine several tests indicates that the effect of the laws of evolution can be profitably studied in these bacteria of the normal mouth. It would seem that the streptococci that are most abundant and constant in human saliva have either acquired, or have had developed in them, attributes which distinguish them from certain other streptococci found elsewhere. Moreover, some of the latter streptococci, of environment other than oral, differ from streptococci of saliva not merely in the passive sense, that is to say, in failing to exhibit capacities possessed by the former streptococci, but differ actively as it were also; they exhibit capacities or functions which in streptococci of saliva are either suppressed or have never been acquired.

There is at present no reason to suppose that those biochemical capacities of streptococci that have been the special object of comparison in the present investigation are, on the whole, any less permanently possessed by them than are those biochemical capacities of certain bacilli by the existence of which such bacilli have been for some time past differentiated and identified.*

The investigation of staphylococci which has been undertaken has shown that in some important respects their biochemical characters are remarkably different from those of streptococci. But, as is the case with streptococci, comparison between various staphylococci in regard to nine selected actions has revealed differences not merely of degree, but of kind, and has shown that a differentiation far more elaborate than has yet been supposed to exist naturally obtains amongst staphylococci.

The difference between the characters of streptococci of saliva and those found elsewhere admits of practical application for the purpose of identifying particles of saliva. Conversely, there is reason to suspect that the attributes of streptococci of environment other than oral may on occasion be applicable for determining the significance of the presence of such individual streptococci.

Further enquiry is necessary to determine the extent to which differences between the characters of staphylococci of diverse environment can be applied for determining the significance of such staphylococci when met with in air, water, dust, or food.

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* For instance, the production of clot in litmus-milk, the reduction of neutral-red broth, and the production of acid and gas in glucose and lactose,—properties that at once distinguish B. coli communis from B. typhosus. Again, acid-production in glucose broth,—a property that differentiates true B. diphtheriae from Hofmann's bacillus.

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The results of the present enquiry, however, would appear to have a practical application more direct than to furnish means for detecting the presence of material liable to convey morbific virus. Notwithstanding that artificial sepsis is largely prevented to-day, disease processes referred to streptococci and staphylococci are of such frequent occurrence that any further knowledge of the characters of these causative agents has a direct pathological interest. Too few pathogenic staphylococci have yet been submitted to available differential tests to enable a statement to be made with regard to them; but a reasonable number of pathogenic streptococci have been examined and with results of considerable importance. The investigation that has already been made by applying the nine differential tests to streptococci isolated from various disease processes has revealed differences between these streptococci quite at variance with views expressed by Marmorek, Aronson and many others with regard to the nature of streptococci. Whatever the ancestry of streptococcus, the facts brought out in the present enquiry dissipate the notion that all streptococci are to-day practically indistinguishable except in the single attribute of virulence. But while the tests described in this report have differentiated streptococci isolated from various septic processes into several distinct and apparently stable kinds, the same tests, when applied to streptococci isolated from cases of ulcerative endocarditis, have identified them with streptococci abundantly present in an apparently non-virulent condition in normal human saliva.

Knowledge of the evolution, relations, and attributes of streptococci, then, is of considerable importance to the pathologist. Nor should it be forgotten that pathological effects which certain streptococci are capable of producing in the human or animal body are as much the outcome of their biochemical activity as is the decomposition of an organic compound manifested by the development of an acid reaction in an artificial culture tube at 37° C.

No. 5.

Report on the Influence of Symbiosis on the Virulence of Pathogenic Microbes: By Dr. E. Klein, F.R.S.

Epidemiological experience teaches that in the causation of a given infectious disease at least three factors come into play: (1) the *causa causans* or the essential cause of the disease, *i.e.*, the specific microbe, or the contagium; (2) the susceptibility to the particular infection of the individual into which the contagium finds entrance, *i.e.*, the host; (3) the conditions under which the interaction of contagium and host takes place.

As regards the first, viz., the *materies morbi* or the specific microbe, there can be no doubt that this must remain the most important factor; for obviously without it neither the second nor the third factors can come into play, and accordingly it is unnecessary in view of the great and solid advances in bacteriology and parasitology to further discuss this axiom. It has, indeed, become so well established that even in those instances in which the nature of the contagium remains still undiscovered, *e.g.* small-pox and vaccinia, syphilis and others, the existence of a specific microbe is universally assumed.

It is different, however, with the second factor, *i.e.*, the susceptibility of the host. While there can be no diversity of opinion as to the facts of natural and of acquired immunity against a given specific microbe, the nature of this immunity is still far from having been solved. True, a number of theories have within the last 10 or 15 years gradually made their appearance, and, as observations and experiments increased, have either had to be abandoned or supplemented and extended to suit the latest facts and observations. So there has resulted a common arena, as it were, in which Greek terms short and long of somewhat doubtful etymological correctness are made to do duty in explanation, in some sort, of a number of new and insufficiently understood experiments. I am not desiring to cast any doubt on the correctness of numerous experimental facts and observations which have been published since the first record, some six years ago, of the experiments and observations by Ehrlich in reference to his famous Seitenkettentheorie, or on the highly important observations on Hæmolysis which at the present day seem to hold the field: but what I wish to point out is that notwithstanding all the numerous experiments in both these regions of research (Wassermann, Pfeiffer and a host of workers) the intimate pathology of natural, as also of acquired, immunity is still awaiting a simple and intelligible explanation; such explanation as would embrace and cover *all* facts. The former explanations of the presence of chemical substances—as for instance Alexines in natural, of Anti-toxins and Germicidal substances in acquired immunity—though

they do not pretend to give a deep insight into the intimate nature of these substances have at any rate this to recommend them that they are not encumbered by a string of compound Greek names of constantly increasing number, such as are arising in connection with each new set of experiments whether by a new investigator or by a gratuitous interpreter of other people's observations.

Leaving, then, this intricate subject of the theories of immunity, and restricting consideration to the epidemiologically well-known fact of the existence or the non-existence of greater or lesser degrees of susceptibility to infection of particular individuals, some of whom have been immunised by previous infection, towards a particular microbe, the following alternatives in explanation present themselves: the greater or lesser susceptibility of one individual as compared with another to a particular infectious disease may be due (*a*) to differences in virulence of the contagium; or (*b*) it may be due to something inherent in the blood and tissues of the host in the one case and not in the other. I myself, on a balance of considerations, am disposed to regard the individual along with his surroundings and accessory conditions as responsible in the one case for his infection, in the other case for his escape from the disease.

It has been experimentally proved by a large number of observations—which go to confirm the experience of physicians and of epidemiologists—that various conditions, generally referred to as lowering of the vitality and vigour of the individual, as, for instance, nervous depression, bad and insufficient food, fatigue, alcoholism, and some organic poisons, a general diseased state, exposure to extreme temperatures, &c., have a marked effect in enhancing the susceptibility of the individual.

It is likewise experimentally proved that for positive result the manner and channel by which the specific microbe is given entrance to the animal body plays an important part in determining infection. Thus, while for experimental infection with bacillus anthracis, B. pestis, B. septicæmiæ hæmorrhagicae, inoculation is the most effective mode of infection, introduction of the contagium by way of the digestive tract appears to be, if not the only, at any rate the readiest, mode, of infection of the human subject, *e.g.*, in diphtheria, scarlatina, typhoid fever and cholera.

These conditions, as also local and seasonal conditions at present not understood in their nature, I propose to leave out of account as outside the scope of my inquiry.

At present I concern myself with the individual animal of a given species in its different susceptibility to a specific microbe, assuming for the moment that the various physical and bodily conditions, such as have been mentioned above as increasing the susceptibility in a general way, do not obtain.

Thus considered, any observed difference in susceptibility might be due either to different vulnerability, as it were, of the normal tissues, or to a difference of action of the specific microbe on these tissues. In illustration of the former I cite the success of

inoculation in one animal, whereas infective material of the same nature and amount introduced in precisely the same manner into another animal of the same species and living under precisely the same conditions fails to produce definite effect.* As regards the latter, *i.e.*, the difference of action of the specific microbe on the tissues, there is for example the localisation of disease in one or another particular organ, in tubercle, in glanders, in plague of man, &c.

It will appear from the foregoing considerations that the problems of the susceptibility of the normal individual, as also of the infective power of the microbe itself, are of very complex and many-sided nature, and that all that may in the present conveniently be done in resolving this complexity, is to select for particular inquiry one after another these several aspects of the subject.

In the following observations and experiments I shall attempt to ascertain how far the simultaneous or symbiotic action of two specific microbes affects on the one hand the susceptibility of the individual animal, and on the other the virulence of one or the other of the specific microbes in question.

In former reports (Report of the Medical Officer for 1889–1890) I have recorded observations which show that the injection of two pathogenic microbes (symbiosis) into the same animal body has in some definite instances the result that each species of microbe is capable of neutralising the other so that no pathogenic result follows; whereas in other definite instances no antagonistic action the one on the other of the two microbes is witnessed, inasmuch as either the one or the other causes its typical pathogenic effect.

In the present paper I deal with symbiotic† action in a different sense, the question submitted to me for answer being this:—Granted an originally pathogenic microbe which, again and again, when inoculated into an animal, *does not* for one reason or another exert its pathogenic effect, is it possible to render such animal susceptible to that microbe by fostering the latter within the animal under symbiotic conditions, *i.e.*, in company with another microbe of one or another kind? This subject was suggested by clinical and epidemiological experience of the following nature:

On inquiring into the history of typhoid attacks in the human subject the following story is not uncommonly elicited: The person on a particular day—sometimes the day after having partaken of a particular article (oysters)—was taken ill with headache, sickness, and possibly also with diarrhœa. But this illness was only of short duration; in a day or two the person seemingly recovered and went about as usual. Nevertheless, in 10 or 12

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* Such instances are not uncommon in experiments with various species of microbes belonging to the group bacillus septicæmiæ hæmorrhagicae and others.

† The term "symbiotic" is used here to express synchronous co-existence of two microbes in the animal body, irrespective of the fact whether or no they are mutually useful.

days, i.e., after lapse of the usual incubation period for typhoid fever, the symptoms of enteric fever in this person became noticeable.

It is obvious that in such instance the first illness was not typhoid fever; that it was some other acute gastro-enteritic disturbance caused in all probability by something other than the typhoid bacillus—the latter not manifesting its action until 10–12 or more days later.

I submit that the first acute transient illness was due to a microbe taken in at the same time as the typhoid bacillus but acting speedily and in an acute manner. I have shown elsewhere that B. coli in some ice-creams is of highly pathogenic nature; when guinea-pigs and mice were fed on it they succumbed under appearances of acute gastro enteritis. Similarly the variety of B. coli known as B. Gaertner is capable of causing acute gastro-enteritis in the human subject, and it is highly probable that some other varieties of B. coli act in a similar manner.

About the time that Emsworth oysters caused the well-known epidemic outbreak of typhoid fever amongst those who partook of them at the Mayor of Winchester's banquet on November 10th, 1902, I examined oysters derived from the same pit as those in question, and I found in some of them distinct evidence of the presence of the typical B. Gaertner.* Now, it will be remembered from the history of the cases that some of the consumers were seized with acute gastro-enteric illness within a few hours of attending the banquet. This initial early illness was clearly not typhoid fever, and I consider that it was due to ingestion of the Gaertner microbe present along with the B. typhosus in those oysters.

Another instance which I may adduce in this connexion is the following: In the Medical Officer's report on Cholera in England in 1893, Dr. Theodore Thomson in describing the advent of cholera in Hull, gives account of the occurrence of fatal Asiatic cholera in a boy who with several others bathed in a particular polluted water—the Sutton Dyke. Several of these bathers were soon after taken ill with gastro-enteric disturbance, but only one of the boys developed true cholera. I submit that here also all imbibed a microbe which caused in some of them gastro-enteric disturbance, and that in one boy only was the cholera microbe also ingested; and I myself suspect that had this boy not swallowed a gastro-enteritis microbe as well as a vibrio he might have escaped development of cholera notwithstanding the presence in his body of the cholera microbe. That this vibrio could not have been present in the water very copiously in its active virulent state, is shown by the fact that except this boy all the others escaped cholera. In the same report will be found in the appendix the result of the bacterioscopic analysis made by me of the water of the Sutton Dyke. I showed the presence therein of a vibrio similar to, though in some important respects different from, the typical cholera vibrio; and I raised presumption that

* Report of the Medical Officer of the City Corporation.

though present in the water this vibrio was not typical either in culture or in action but that it became so while growing in the intestine of the boy afterwards attacked by cholera. It is common knowledge that specifically cholera-polluted water (just like typhoid-polluted water) is capable of causing the disease only in certain of the consumers of it, and it is quite possible that in some persons in whom it causes cholera it does so on account and in consequence of simultaneous ingestion of some other acutely-acting intestinal microbe. I shall presently bring forward experimental evidence to show that this is not a bare supposition; that it has a certain basis of fact.

Lastly, I may mention the well-recognised facts concerning the greater severity of attacks of illness such as diphtheria, tuberculosis, and scarlatina owing to the simultaneous presence and symbiotic action of another and particular microbe, *i.e.*, streptococcus pyogenes.

SERIES 1.

Experiments with B. typhosus.

The experiments in this series were made in this way. A certain amount of an emulsion of a recent agar culture of the current laboratory B. typhosus was mixed with a certain amount of a similar agar culture of one or other of different microbes, and the mixture was in each instance injected intraperitoneally into a guinea-pig.

The laboratory B. typhosus in question had been originally (some two years previously) derived from the spleen of a fatal case of typhoid fever, and had been kept up in stock by sub-culturing every 4–6 weeks. At the date of commencement of these experiments, two platinum loops of a two days' old agar culture of the microbe at 37° C. did not, injected into the peritoneal cavity of a half to full grown guinea-pig, produce generally any result. A year or two earlier this amount of agar culture of this bacillus did certainly cause in such animal, within 20–24 hours, peritonitis and death, with copious viscid exudation crowded with the bacilli. Like some other microbes, after many generations of subculture in the laboratory this B. typhosus has in course of time lost much of its virulence. At present, after the injection of a small dose of it into the peritoneum it rapidly disintegrates and disappears; the animal remains unaffected, and when killed, say, after two days or less, the peritoneum is found normal and no culture of typhoid bacillus can be established from the peritoneal fluid.

Experiment 1.—A half-grown guinea-pig was injected intraperitoneally with the following mixture of microbes, both of them taken from 2 day's old agar surface cultures:—

(*a*) Laboratory typhoid bacillis, 2 platinum loops of solid growth emulsified in sterile broth,

(*b*) Bouillon emulsion of half a platinum loop of solid growth of a virulent B. coli communis, isolated some time previously from the sediment of the water of the river Lea.

A control experiment had shown that a half loop of this coli culture injected peritoneally as bouillon emulsion killed without fail a half-grown guinea-pig in 24-36 hours.

The mixture of the above two emulsions—viz., B. typhosus and B. coli (Lea River)—caused the death of the half-grown guinea-pig within 20 hours. On post-mortem examination the following condition was found:—the peritoneum contained copious thick fluid sanguineous exudation densely crowded with bacilli; the intestines in almost their entire length were dark red, intensely congested.

In order to ascertain the nature of the bacilli in the peritoneal exudation, a drop of this was diluted with a few cubic centimetres of sterile broth, and a few drops of this dilution were rubbed over the surface of Drigalski-Conradi medium set previously in a sterile plate dish. On incubation for 24 hours at 37° C. crowds of colonies were seen, all of them of the same nature, viz., that of the B. coli used for injection. They were red colonies with red halo, and amongst them no bluish colonies, that might have been B. typhosus, could be discerned. The exudation therefore contained only the B. coli. Although the number of B. typhosus injected was about four times as great as that of the B. coli, yet only the latter had multiplied in the peritoneum. The death of the animal could therefore have been due only to the B. coli. Consequently the presence and multiplication of the B. coli in this animal's peritoneum had no influence in fostering the injected B. typhosus; the latter behaved just as if it had been injected alone, *i.e.*, it disappeared.

Experiment 2.—The above experiment was repeated, the sole modification being that I employed a little less than half a loop of the B. coli and fully two loops of B. typhosus. The guinea-pig died in about 24 hours.

On post-mortem examination the whole of the intestine and peritoneum was found intensely congested; the peritoneal cavity contained a fair amount of fluid sanguineous exudation crowded with bacilli. A Drigalski-Conradi plate was inoculated with a dilution of this exudation, with the result that here also a pure culture of the B. coli was obtained; no colonies of B. typhosus made their appearance on the plate.

Experiment 3.—Repetition of the above experiment with much smaller amounts. Thus: $\frac{1}{8}$ of a loop of the B. coli and about 1–1½ loops of the B. typhosus.

The animal was found dead within 20 hours. The post-mortem appearances and the result of the Drigalski plate culture of the sanguineous peritoneal exudation were exactly the same as in the previous cases, viz., growth and multiplication of the B. coli but no trace at all of the B. typhosus. That is to say, the B. coli

acted in the peritoneum so rapidly and so virulently as to leave no scope for the B. typhosus introduced at the same time into the same cavity.

This difficulty, viz., the too rapid and too virulent action of one microbe leaving no scope for the second microbe is a serious difficulty in experiments of this nature, as will appear also in other experiments later on, This difficulty is by no means easy of a remedy. At first sight it might be thought that by diminishing the amount of the more virulent microbe the difficulty could be overcome. This is, however, by no means necessarily the case, and for this reason: dealing with a highly virulent microbe like the B. coli, the amount of culture which is still capable of producing a pathogenic result may be and generally is extremely small, and further reduction of the amount entails risk that no action at all would be produced. As a matter of fact as a result of a series of experiments made for this very purpose on ten guinea-pigs, I came to the conclusion that of a surface agar culture two days grown at 37° C. the minimal fatal dose lies between $\frac{1}{32}$ and $\frac{1}{64}$ of a culture; in one further case, the eleventh, even $\frac{1}{128}$ of a culture intraperitoneally injected caused death, while in a twelfth case $\frac{1}{32}$ of a culture caused no result. The fact is that the animal body is not a test tube, and the interaction between living culture of a microbe and the animal body is not exactly the same as the interaction between two definite chemical substances determinable by quantity.

Accordingly, for the reason that a microbe of the above kind is too virulent and not sufficiently easily manageable for experiments of symbiosis with a slightly pathogenic B. typhosus, I desisted from further use of the Lea River B. coli.

I should here state that in a considerable number of experiments made as controls for one or the other microbe, the control animals died as well as the other animals injected with the mixture of microbes. These other experiments need not be described, the death of the controls having frustrated comparison. Similar negative experiments I have had, not only in the case of the B. coli just mentioned but also with others (micrococcus hæmorrhagicus, proteus, and others), and with the typhoid bacillus. In these experiments the difficulty in gauging the amount of culture for sub-fatal effect could not be overcome.

For the above B. coli (Lea River water) I substituted therefore in my further experiments a B. coli communis obtained from a sample of ice cream, which had caused in consumers of it distinct and intense acute gastro-enteritis. This ice-cream contained B. coli in great abundance; and the microbes proved virulent, causing fatal septicæmia in guinea-pigs on subcutaneous injection. Also when ingested by guinea-pigs and mice it produced acute gastro-enteritis. Further, I altered my experiment in the sense that I did not inject a mixture of the ice-cream B. coli and the typhoid bacillus into the peritoneum, fearing a failure as in the former experiments owing to the high virulence of the former; but I injected one day the former, *i.e.*, the ice-cream B. coli, subcutaneously, and next day injected the laboratory B. typhosus intraperitoneally.

All the microbes belonging to the coli-typhoid group (as also some others) act on the guinea-pig when injected intraperitoneally more intensely than when injected subcutaneously. In my report for 1894-1895 I have described a large number of experiments proving this for B. coli, B. typhosus, Vibrio choleræ, and other microbes.

Experiment 4.—Two guinea-pigs were injected subcutaneously with a small amount of a four days' old agar culture of the ice-cream B. coli, about half a platinum loop being used for each animal. Previous experiments had shown me that of a four days' old agar culture (which, as also in the case of other microbes, is less virulent than a 24 hours' or a two days' culture), half a loop injected subcutaneously causes a spreading gelatinous swelling about the seat of inoculation, the animal becoming at the same time generally affected in that it is quiet and off its feed next day. As a rule it recovers, although the sanguineous exudation causing the swelling is found, when examined, 24 hours after injection, under the microscope and by culture, to contain abundance of the bacilli.

The above two guinea-pigs 24 hours after injection were found to have unilaterally much soft gelatinous swelling of the subcutaneous tissue about the region of the primary injection, and they were quiet and a little off their feed. One of these guinea-pigs (for convenience named "black") received now intraperitoneally about one loop of a two days' old agar culture of the laboratory B. typhosus. The other guinea-pig (for convenience called "white") was reserved as a control.

The result was interesting. Next day the "black" guinea-pig died, *i.e.*, about 24 hours after the injection of the B. typhosus. The "white" guinea-pig remained alive and was distinctly better, the swelling having become firmer, the animal livelier and feeding more freely. Post-mortem examination of the "black" guinea-pig showed hæmorrhage in the omentum; the intestines were much congested; in the peritoneum there was viscid grey exudation, which, under the microscope, showed numerous leucocytes and crowds of bacilli. Stained film specimens showed also that many of the leucocytes included bacilli in their protoplasm.

Cultures were made with the exudation—after dilution—on the surface of Drigalski-Conradi plates, and it was thereby ascertained that the exudation contained the B. typhosus in pure culture. Sub-culture from a single colony was subjected to the agglutination test with blood serum of the laboratory rabbit (protected by previous repeated injection with laboratory typhoid culture), and with positive result.

But a further interesting fact was elicited by injection of a guinea-pig with the sub-culture of this B. typhosus derived from this guinea-pig. A little less than one loop of the growth of a three days old gelatine culture injected into the peritoneum of a guinea-pig caused death within 20 hours. On post-mortem examination the peritoneum was found deeply congested, and containing grey viscid exudation which was densely packed with a pure culture of the typhoid bacillus.

From this experiment it appears that, under the above condition of symbiosis, the typhoid bacillus, which when used alone produced no effect on the animal and disappeared from its peritoneum, became in its action markedly enhanced. The ice-cream coli had previously prepared, as it were, the animal's body; that is to say, B. typhosus growing symbiotically with this B. coli in the body of the guinea-pig became capable of multiplying and causing the death of the animal. On subculture of the B. typhosus recovered from the peritoneum of this new host, this microbe proved to be on further injection of a virulent nature. Thus, before its passage through the first animal it was in large dose inactive, whereas by its passage through that animal had become endowed with fatal pathogenicity though employed in small dose. The experiment being of great importance was therefore repeated in the following manner :—

Experiment 5.—One guinea-pig (termed for convenience "black and white") was injected subcutaneously per axillam with about half a loop of the ice-cream B. coli. Next day the animal showed good gelatinous swelling of the subcutaneous tissue of the axilla and chest, but otherwise seemed little affected. It was now injected intraperitoneally with one-fifth of a four months old gelatine surface culture of the laboratory typhoid bacillus. As controls I selected two guinea-pigs :—

(*a*) a "brown and white" guinea-pig which had been injected per axillam the day previous with a like dose of the ice-cream B. coli, and

(*b*) a "black and brown" guinea-pig, which received intraperitoneally at the same time as the "black and white" guinea-pig a like dose of the typhoid culture that is to say, guinea-pig (*a*) served as control for the ice-cream B. coli, guinea-pig (*b*) as control for the B. typhosus guinea-pig.

The result of this experiment was highly instructive : control (*a*) ("brown and white") showed after 24 hours similar gelatinous swelling in axilla and chest, which disappeared completely in a few days. The B. typhosus control guinea-pig (*b*) remained alive and well, but the "black and white" experimental guinea-pig (B. coli *plus* B. typhosus) was found dead in 20 hours after intraperitoneal injection with the B. typhosus. Its post-mortem appearances were these : extensive hæmorrhagic infiltration of the subcutaneous tissues of the axilla, chest, and upper part of the abdomen on the inoculated side, the sanguineous fluid being densely filled in pure culture with the ice-cream B. coli. The peritoneal cavity contained a good deal of viscid grey exudation. Under the microscope this showed crowds of bacilli and numerous leucocytes, most of the leucocytes containing in their interior B. typhosus. A Drigalski plate inoculated with a dilution of the exudation produced crowds of colonies of the B. typhosus in pure culture.

From this experiment it is seen that not only had the B. typhosus (injected) lived and multiplied within the peritoneal cavity, but

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also that the Ice-cream B. coli lived and thrived well in the subcutaneous tissue; that is to say, under the particular conditions of symbiosis the two microbes exerted a mutual enhancing action. Each microbe alone had not been capable of living and thriving in a separate control host; they died off there and left the animal uninjured; but under the symbiotic condition they lived and thrived well and produced fatal effects.

Experiment 6.—In this experiment I substituted for the ice-cream B. coli, B. Gaertner. This microbe has been kept for many generations of subculture in the laboratory, in all over three years. When used from a recent sub-culture, *i.e.*, one only a few days old, it is still of a considerable degree of virulence, but its virulence is in a sense under control. I can with tolerable certainty determine a dose which, while locally active, *i.e.*, though producing on subcutaneous injection distinct gelatinous swelling, and making the animal generally slightly but temporarily ill, does not cause death of the animal. After two or three days the local tumour diminishes in size and becomes firm; later suppuration and slight ulceration occur, but the animal eventually quite recovers. For a different object, I had made a large number of experiments on guinea-pigs with the above laboratory B. Gaertner, and had found that using a gelatine culture 24 hours old, and injecting half a loop (as bouillon emulsion) subcutaneously, the animal develops a gelatinous swelling in 24 hours, is a little quiet and off its feed, but eventually quite recovers. I have, therefore, not deemed it necessary in the following experiment to inject separately a control guinea-pig with this B. Gaertner alone.

One guinea-pig (white) received per axillam subcutaneously half a loop of a 24 hours gelatine culture of this Gaertner bacillus. Next day there was a good gelatinous swelling about the axilla and upper part of the chest on the inoculated side. I injected now intraperitoneally this (white) guinea-pig with about one-twelfth of a three weeks old gelatine culture of the laboratory B. typhosus. At the same time I injected intraperitoneally with a like dose a control guinea-pig (black and brown). Next day the white guinea-pig was dying, whereas the control animal (black and brown) was living, though slightly quiet. This control animal was found quite lively and normal the next day and it remained so.

The mixed-injection guinea-pig (white) died in the course of the day, and gave post-mortem appearances as follows: great and extensive hæmorrhagic infiltration of the subcutaneous tissue at the seat of Gaertner inoculation; the peritoneal cavity contained viscid grey exudation which under the microscope showed many leucocytes and some bacilli. A Drigalski plate inoculated with a droplet of the exudation showed after 24 hours' incubation very numerous colonies of the B. typhosus in pure culture.

This experiment, therefore, affords further evidence that the laboratory typhoid bacillus which in a certain dose is not capable of living and multiplying in the peritoneal cavity of a guinea-pig, was enabled so to do when introduced into an animal in which the laboratory B. Gaertner had, so to speak, taken root. There

can, then, be no doubt as to the fact that the B. typhosus which in a certain strain and in certain dose does not live and thrive in the peritoneum of a guinea-pig, can be made to grow and to thrive there and to act virulently if only it be introduced into such animal symbiotically with another pathogenic coli-like microbe, as for instance Ice-cream B. coli and B. Gaertner.

Experiment 7.—Having shown by experiments 4 and 5 that the Ice-cream B. coli has a distinct enhancing influence on B. typhosus, a further experiment was performed to ascertain whether a similar enhancing action on the B. typhosus within the animal body is exerted by *the toxins* of the Ice-cream B. coli produced by this microbe while growing outside the animal body, *i.e.*, in an artificial culture. For this purpose broth cultures of the Ice-cream B. coli were made and incubated at 37° C. for 14 days. The uniformly turbid broth was then filtered through three layers of fine filter paper. This filtrate, which was quite clear, was heated for 15 minutes at 70° C. By this means any stray bacillus remaining in the filtrate would be killed; as a matter of fact cultures of this filtrate proved sterile.

The filtrate so sterilised was employed as follows: five cubic centimeters were subcutaneously injected into two guinea-pigs. Two hours and a half later there was in both animals a distinct soft swelling about the seat of inoculation, but the animals appeared otherwise lively and normal. At this stage, one of them, guinea-pig (*a*), was injected intraperitoneally with about $\frac{1}{10}$ of an agar culture (3 weeks old) of the laboratory B. typhosus, another and control guinea-pig, (*b*), receiving at the same time also intraperitoneally a like dose of the same culture of B. typhosus.

The result was interesting. Within 20 hours after the typhoid bacillus injection the first guinea-pig (*a*) was found dead, but the control guinea-pig (*b*) remained quite unaffected. On post-mortem of guinea-pig (*a*)* the subcutaneous tissue at the seat of inoculation with the filtrate contained a lot of sanguineous fluid, but no bacilli would be detected in it; the peritoneal cavity contained copious grey viscid exudation, crowded with bacilli. A Drigalski plate made with a drop of a dilution of this exudation yielded on incubation crowds of colonies of B. typhosus in pure culture.

A sub-culture was made from one of these colonies, and a trace of it was next day injected intraperitoneally into a further guinea-pig. This animal was found dead in 20 hours with the typical appearances, the peritoneal exudation being crowded with B. typhosus in pure culture.

From this experiment it appears that the chemical products of the Ice cream B. coli injected into a guinea-pig enabled the typhoid bacillus to live and multiply in the peritoneal cavity of the animal and to produce a fatal result; and that moreover the

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* That the injection of 5 cc. of the filtrate was not responsible for the fatal results is shown by the fact that the companion guinea-pig which received at the same time 5 cc. of the filtrate remained alive and well. Later on it was, as will be seen, used for injection with vibrio cholerae.

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Influence ymbiosis he ulence of hogenic robes, by Klein, 8

typhoid bacilli taken from the dead body of this animal proved of high degree of virulence for another guinea-pig.

There is, then, in this experiment a corroboration of experiment 4. It might of course be contended that the two experiments are not quite comparable; that in the former case (experiment 4) the enhanced action and virulence of the B. typhosus was caused by symbiosis with the living Ice-cream B. coli, whereas in experiment 7 the chemical products (toxins) of the colon bacilli alone were used; and that, therefore, it is incorrect to speak of symbiosis where living bacilli of one sort only were injected. This apparent difference is, however, on closer consideration not real. Using the living B. coli for the first injection does not produce the enhancement of the B. typhosus through any direct action of the former microbe on the latter. Clearly the result is due to the action of the chemical products of B. coli on the animal body, enabling the latter to allow the B. typhosus to live and thrive in it. In all microbic action it is essentially the chemical action (the toxin) of the invading microbe which causes the specific changes in the animal body, and it makes no fundamental difference whether in the one case the pathogenic microbe is allowed to grow in that body and to modify its tissues comparatively gradually by means of the toxin manufactured there, or whether in the other case the microbe is encouraged to produce its toxin outside the body, *i.e.*, in artificial culture, for the purpose of introducing this toxic agent, as it were, at one blow; the known facts, that the toxins of many microbes (anthrax, typhoid, coli, cholera, tetanus, diphtheria) possess the same activities whether produced within or outside the animal body, are examples in point.

Hitherto I have dealt with the interaction within the animal body of the B. typhosus and certain aerobic microbes belonging to the same group, viz., Ice-cream B. coli, and B. Gaertner. In the next experiment I substituted for these latter particular pathogenic anaerobes, viz., B (enteritidis) sporogenes and a new highly virulent anaerobe which I recently discovered, viz., B. carnis, to be presently described in detail.

Before dealing with these experiments I would refer to the difficulty under which some bacteriologists appear still to labour in identification of bacillus (enteritidis) sporogenes. Identification of this microbe seems to me one of the simplest things imaginable, if only proper methods are used; far simpler for instance than the identification of B. coli communis or of B. typhosus.

In a number of publications, the last as recently as 1901-1902,* I have described these methods, and yet there appears in the recently issued Report on Shell Fish Pollution by the Local Government Board of Ireland the following statements:—

"I very much doubt the significance of the presence of B. enteritidis. Even when the milk tubes failed to display the change designated as typical by Klein, microscopic examination has repeatedly shown me the presence of a minority of

* Reports of the Medical Officer for 1901-1902, p. .

anthrax-like, Gram-staining, non-sporing rods, evidently enteritidis, but enteritidis which had failed to get the upper hand owing to the prevalence of some other obligate or facultative anaerobic competitor."

This would seem to signify that the observer failing to get the first and most characteristic indication of the presence of B. enteritidis, viz., the milk culture change, is content to identify this microbe by its morphological characters alone. Now it should be well known, that a host of anaerobes (B sporogenes, B cadaveris, B emphysematosus (Cheauvaux), B. spinosus, B. radiatus, B. butyricus, B. carnicola, B carnis, B. mucosus) possess all the characters which appear to have been relied on in the identification in question; and that of all these, B. butyricus alone gives, like B. enteritidis sporogenes, a very special milk change. The very least, therefore, that should have been done in the circumstances for identification of the real B. sporogenes was its isolation by subculture followed by animal experiment. That milk containing the spores of the B. sporogenes in however scanty proportion to the other anaerobic microbes above enumerated should, on anaerobic incubation at 37°, have failed to produce, sooner or later, the typical change in the milk, is a surprise to me. In the course of a considerable experience in this matter I have always found (as has also Dr. Houston in his extensive experience with sewage) that under these conditions B. sporogenes is sure to assert itself against all comers. However this may be, there is no question at all that "anthrax-like Gram-staining sporeless rods" could *not* have been B enteritidis sporogenes.

With reference to a further statement that, "I have been obliged to conclude that enteritidis is a very frequent denizen of molluscs and the sandy mud, &c., &c.," it is to be observed that this is opposed to the experience of other observers. I, myself, as the result of analysis of a very large number of molluscs (oysters), find that these molluscs only rarely contain this microbe; that in fact even when oysters contained abundance of B. coli communis in small quantities (a few drops to $\frac{1}{2}$ c.c.) the spores of B. enteritidis could not be demonstrated in much larger amounts, 1-2 c.c., of them. This need surprise no one, since B. coli communis is about a thousand times as numerous in sewage as B. (enteritidis) sporogenes.

Experiment 8.—A guinea-pig was injected intraperitoneally with a mixture of $\frac{1}{2}$ cc. of the whey of a typically changed enteritidis milk culture and of $\frac{1}{2}$ cc. of a thin emulsion of the growth of a 10 days old agar culture of the laboratory B. typhosus. This amount of the whey ($\frac{1}{2}$ cc.) on intraperitoneal injection in a control guinea-pig produced no result beyond temporary quietness, nor did the above amount of the typhoid emulsion cause any illness in another control guinea-pig. But the guinea-pig injected with the mixture was found dead within 18 hours. On post-mortem examination it showed a fair amount of grey viscid exudation in the peritoneal cavity, and thick clumps of lymph on the surface of the liver and the stomach. The peritoneal fluid contained, beside numerous leucocytes, dense masses of bacilli in shape and size like those of B. typhosus. Not only were these bacilli densely packed in the fluid medium, but numbers of the leucocytes contained bacilli in their interior, many of these intracellular bacilli showing Pfeiffer's phenomenon of disintegration and involution. An (aerobic) Drigalski plate made with a droplet of the exudation showed, on incubation for 24 hours at 37° C., crowds of colonies (blue) of B. typhosus in pure culture.

The injection therefore of the otherwise inactive culture of B. typhosus together with the culture of B. sporogenes caused the former to acquire activity and to become capable of growing and multiplying in the peritoneal cavity.

Experiment 9.—This experiment was in effect a repetition of the previous experiment. One guinea-pig was in[jected] peritoneally with a mixture of $\frac{1}{2}$ cc. of the wh[ey]

old typical enteritidis milk culture and about half a loop of a nine days old agar culture of the laboratory B. typhosus. A control guinea-pig was at the same time injected intraperitoneally with the same amount (half a loop) of the same culture of B. typhosus, and a second control animal was injected intraperitoneally with ½ cc. of the same enteritidis milk culture. As a result, while the control typhoid guinea-pig remained unaffected, the control enteritidis guinea-pig, as also the guinea-pig injected with the mixture, were ill in the evening and were found dead in about 20 hours.

Post-mortem examination of the control enteritidis guinea-pig showed that intestines were relaxed and hyperaemic: the peritoneal cavity contained fluid in which were seen numerous chains and filaments proved by staining and culture to be those of the B. sporogenes. In my report for 1897 I have described these filaments and chains after intraperitoneal injection as characteristic of this particular micro-organism.

Similarly examination of guinea-pig injected with the mixture showed great congestion of the peritoneum and the intestine with fluid in the peritoneal cavity. In this fluid however there were present Gram-staining chains and filaments (B. sporogenes) and numerous smaller bacilli which did not take the Gram-stain. A droplet of the exudation used in inoculation of an (aerobic) Drigalski plate yielded crowds of (blue) colonies of typical B. typhosus in pure culture.

It is then clear from this experiment that the presence of the B. sporogenes enabled the B. typhosus (which was inactive in the control guinea-pig) to grow and to abundantly multiply in the peritoneal cavity.

Experiment 10. In this experiment instead of B. sporogenes in a milk culture this microbe was taken from an agar surface, was emulsified in sterile bouillon, and then mixed with a small dose (about half a loop) of an inactive agar culture of the laboratory B. typhosus. This mixture was injected into the peritoneal cavity of a guinea-pig; a control guinea-pig received at the same time intraperitoneally a like dose of the B. sporogenes emulsion alone.

The former guinea-pig was found dead within 20 hours; the control animal died in about 26–28 hours.

The post-mortem appearances of the "mixed-injection" guinea-pig showed great congestion of the peritoneum, with grey viscid exudation. Under the microscope this exudation contained abundance of bacilli of the size of B. typhosus and not taking the Gram stain. Inoculation of a Drigalski plate produced crowds of typical colonies of B. typhosus.

This experiment further confirms belief that simultaneous injection of B. sporogenes and B. typhosus enables the latter to rapidly grow and multiply in the animal body.

Experiments were made also with a second pathogenic anaërobe, one hitherto undescribed and which I propose to call *B. carnis*. This microbe is characterised by its high virulence on guinea-pigs and mice. It was found in beef infusion which had been

allowed to putrify spontaneously. The morphological, cultural, and physiological characters of B. carnis are very different from all known pathogenic microbes of this class, and I submit a brief description of the micro-organism.

It consists of cylindical rods, motile, average length 1·5–2·5 μ, thickness 0·6 μ, rounded ends; "gram-positive." It forms readily terminal spores, oval to rod-shaped, up to 2 μ long, 0·8 thick. It does not liquefy blood serum; grows well on agar as translucent more or less angular discs. Milk is not altered by it for some weeks although the microbe grows readily in it. On the surface of gelatine it forms flat translucent discs gradually branching and assuming the aspect of a lichen. In stab gelatine it forms feathery, mossy, branched vertical prolongations, clubbed at the ends. The gelatine is not liquefied.

Guinea-pigs and mice are highly susceptible to subcutaneous inoculation of B. carnis in small doses; a characteristic spreading gelatinous infiltration is produced permeated by thin apparently clear sero-sanguineous fluid containing copious short motile bacilli, some with terminal spores. The inoculated animals die in from 20 and 21 hours. Post-mortem: the small intestine shows occasionally hæmorrhages, and its contents are muco-sanguineous. The spleen as a rule is not enlarged and is pale. Occasionally it shows infarcts: so also the liver. The bacilli are present in the heart's blood in comparatively small number; so also are they present in the infarcts of the spleen and liver.

A small dose of spores produces a like lethal effect with the bacilli. The intraperitoneal injection acts far less virulently.

For obtaining spores of the bacillus, the condensation water of sloped agar cultures, the milk cultures, and the subcutaneous exudation sealed up and incubated at 37° C. are the most ready means.

Experiment 11.—A guinea-pig (*a*) was injected intraperitoneally with a mixture of a small dose ($\frac{1}{10}$ cc.) of milk culture of B. carnis and half a loop of agar culture (one week old) of the laboratory B. typhosus. At the same time a control guinea-pig (*b*) received intraperitoneally a like dose of the same milk culture of B. carnis, while a second control guinea-pig (*c*) received intraperitoneally half a loop of the same culture of B. typhosus.

Guinea-pig (*a*) was found dead next morning, within 20 hours.

Guinea-pig (*b*) was affected after 24 hours, but unfortunately it had large and extensive gelatinous swelling in subcutaneous tissue of the anterior abdominal wall, and it died in 48 hours. Post-mortem examination of (*b*) showed exactly the same condition as is found in guinea-pigs after subcutaneous injection of B. carnis, viz., copious gelatinous infiltration, and sero-sanguineous fluid in the subcutaneous tissue, containing many bacilli showing spores. This would seem to indicate that in the act of injection of this animal per peritoneum some of the fluid—
trace—must have escaped into the
abdomen; a suspicion which is

experience that while very small doses of culture of B. carnis suffice, when injected subcutaneously, to produce the above appearances and to cause death, several times (2–5 times) larger doses of the same culture injected into the peritoneal cavity fail to produce more than a temporary illness, if any; the animal remaining alive.

Guinea-pig (*a*), inoculated with the mixture of B. carnis and B. typhosus and dead within 20 hours, showed on post-mortem examination no change in the subcutaneous tissue of the abdomen, the peritoneal injection having been performed satisfactorily. Its peritoneal cavity contained a large amount of turbid exudation which was literally packed with small bacilli not taking the Gram stain. The B. carnis injected had not, therefore, survived. A Drigalski (aërobic) plate made with a trace of a droplet of this exudation brought forth crowds of B. typhosus in pure culture.

The typhoid control guinea-pig (*c*) remained alive.

From this it appears that this anaërobe B. carnis has a like property of enhancing the action of the B. typhosus with that recorded of the B. (enteritidis) sporogenes.

Experiment 12.—This experiment, a repetition of experiment 11, was for the purpose of securing intraperitoneal injection of B. carnis without accidental subcutaneous inoculation of the guinea-pig.

Guinea-pig (*k*) received per peritoneum a mixture of ½ cc. of a 14 days old milk culture of B. carnis (full of bacilli and spores) and half a loop of a one week old agar culture of the laboratory B. typhosus. A second guinea-pig (*m*) received per peritoneum ½ cc. of the milk culture of B. carnis alone. And a third guinea-pig (*n*) received half a loop of the agar culture of the B. typhosus alone.

As a result, control guinea-pig (*m*) remained quite unaffected (it had no swelling in subcutaneous tissue); and control guinea-pig (*n*) remained quite unaffected. But the "mixture-guinea-pig" (*k*) died in 22 hours. The post-mortem examination of this guinea-pig showed great congestion of the peritoneum and intestines, with pseudo-membranes on liver and stomach; in the peritoneal cavity there was a considerable amount of turbid fluid. Under the microscope this fluid was seen to be full of bacilli, the majority negative (typhoid), some positive (B. carnis), as regards the Gram-stain. Cultures were made of the exudation on aërobic Drigalski plate and on agar surface kept anaërobically, with the result that crowds of typhoid bacillus colonies appeared on the Drigalski plate, and numerous colonies of B. carnis on the anaërobic agar surface.

In view of the fact that control guinea-pigs (*m*) and (*n*) remained unaffected, whereas the peritoneal fluid of the animal (*k*) contained numerous bacilli of both species (B. carnis and B. typhosus), it is safe to conclude that not only is B. typhosus encouraged in a marked manner in its growth and multiplication

by the presence of B. carnis, but that the latter is in turn affected by the former in a similar though less degree.

As a last experiment of this series I cite one which, though single in its character, is instructive. I have obtained from meat infusion, allowed to putrefy spontaneously, a Proteus vulgaris that in all its morphological and cultural characters is identical with the well-known Proteus vulgaris of Hauser which is commonly found in aërobically putrefying albuminous substances; the microbe, par excellence, that is of putrid decomposition taking place under aerobic conditions. The Proteus found by me on the above occasion proved highly virulent for rodents (guinea-pigs); so much so that recent agar cultures of the microbe injected subcutaneously in very small doses caused a rapidly spreading hæmorrhagic infiltration of the subcutaneous tissue and speedy death of the animal. With this microbe I have made a considerable number of experiments on symbiosis with B. typhosus; either injecting a mixture of the two microbes, or injecting Proteus subcutaneously and then B. typhosus intra-peritoneally. But generally I have failed, in either way, to enhance the activities of B. typhosus. This failure has been due to the too rapid multiplication of the Proteus (as indeed is known of most varieties of Proteus vulgaris) and the prompt death of the animal; B. typhosus was in almost every instance altogether crowded out and suppressed, no time being given it for growth and multiplication. But in a particular instance the experiment succeeded in so striking a manner that, though it be but a single experience, I record it in detail. So far as it goes it is in complete support of a general anticipation that the B. typhosus is likely to become enhanced by Proteus vulgaris.

Experiment 13.—Two guinea-pigs (*a* and *b*) were injected subcutaneously per axillam with a trace of the growth of the Proteus taken from the surface of an agar culture 20 hours old. Both guinea-pigs showed next day big gelatinous tumour extending from the axilla over part of the chest and neck on the inoculated side. One guinea-pig (*a*) now received intraperitoneally a trace of culture of B. typhosus (laboratory strain) taken from the surface of a six days' old agar culture; and guinea-pig (*b*) was kept as control. At the same time a third guinea-pig (*c*) was made to serve as control for B. typhosus, being injected intraperitoneally with about half a loop of B. typhosus from the same agar culture.

Guinea-pig (*b*) (control for B. proteus) survived, although a week elapsed before it became again normal.

Guinea-pig (*c*) (control for B. typhosus) was quite lively on the following day and for the two next succeeding days; but on the fifth day it suddenly died. No cause for its death, could however, be found, the peritoneum appearing unaltered.

Guinea-pig (*a*) (inoculated with the mixture of microbes) died about 26 hours after injection with B. typhosus. On post-mortem examination its peritoneum was found much congested, and in its cavity was copious viscid turbid exudation in which were numerous leucocytes and great numbers of typhoid-like bacilli.

Stained film specimens showed that most of the leucocytes were filled with bacilli, many of them being in various phases of involution and disintegration. A Drigalski plate made with a trace of this peritoneal exudation yielded crowds of (blue) colonies of B. typhosus in pure culture.

There can be no doubt, then, that Proteus is capable of enhancing the activities of B. typhosus, this latter under conditions of symbiosis therewith multiplying rapidly in the peritoneal cavity and causing speedy death of the animal.

Series II.

Experiments with Vibrio Cholerae.

The particular vibrio of these experiments was some years ago (1894) obtained from the contents of the ileum of a case of Asiatic cholera which arrived in the port of London from St. Petersburg, where cholera then existed. This vibrio has been several times (1896, 1897 and 1898) mentioned in these reports in connexion with a variety of experiments. It has been retained in the laboratory till the present day, by transferring it to fresh culture media at definite times. It has, however, in the course of years changed in respect of its ability to liquefy gelatine—at present gelatine becomes liquefied by it extremely slowly—,and particularly it has become modified as regards its pathogenicity. When first obtained a small amount of a recent agar culture ($\frac{1}{10}$–$\frac{1}{30}$) injected intraperitoneally was capable of killing a full-grown guinea-pig within 20-24 hours. At the present time even $\frac{1}{2}$–1 agar culture (24–48 hours old) sometimes fails to bring about a fatal result, the animal being commonly only slightly affected and by next day having seemingly recovered. In respect of morphology and formation of cholera red, however, this micro-organism is still the typical vibrio cholerae.

With this "attenuated" laboratory vibrio cholerae the following experiments were made.

Experiment 14.—A guinea-pig was injected intraperitoneally with a mixture of the pathogenic Lea River B. coli (the microbe which as regards amount was used similarly in experiments of Series I.) and about $\frac{3}{4}$ of a cubic centimeter of a thick turbid emulsion of the vibrio. The animal was found dead within 20 hours. The result of the post-mortem examination was identical with that described in regard of experiment I: the peritoneal exudation was crowded with, and yielded on culture a pure culture of, the B. coli. A Drigalski plate made with the (dilute) exudation yielded no colonies of the vibrio nor did a peptone culture yield any vibrios.

[The Drigalski medium is of very great use in identifying colonies of the vibrio cholerae as also of other vibrios. Like other observers, I am using it now constantly also for this purpose. All the vibrios which I have tested yield on the Drigalski medium

small sky blue colonies, much smaller and more distinctly blue than those of B. typhosus. A microscopic specimen of such a small sky blue colony is all that is required to ascertain that a vibrio is in question; but of course for further identification of the exact species of vibrio, subcultures on various media are required.]

Experiment 15.—This experiment was made in the same way as 14, except that a virulent B. coli from faecal matter was mixed with the vibrio. The result was the same, viz., death of the animal due to B. coli. The peritoneal exudation contained no colonies of the vibrio.

Experiment 16.—A guinea-pig was injected intraperitoneally with the Lea River B. coli and with vibrio cholerae exactly as in experiment 14. The animal was found dead within 20 hours. Post-mortem examination showed: sanguineous exudation in the peritoneal cavity, crowded with bacilli (B. coli). But in this instance there were also some vibrios amongst the bacilli. With a platinum loop of the exudation a peptone salt tube was inoculated and incubated at 37° C. Next day the peptone culture showed unmistakable vibrios, and after a further day's incubation showed the characteristic surface pellicle composed of typical vibrios and spirilla. Subcultures and cholera red test proved positive for vibrio cholerae. There was here, then, something approaching a positive result, inasmuch as the vibrio injected had seemingly proved capable of holding its own. It ought, however, to be added that the number of vibrios injected was very great and that the death of the animal by the B. coli having taken place soon, some of the vibrios actually injected may have survived. But on the other hand this is not what generally takes place, viz., 20 hours is generally more than sufficient for the animal's peritoneum to kill off (disintegrate) all vibrios if these are, as in this instance, of the attenuated kind and not otherwise capable of multiplying.

For the above reasons a repetition of the experiment was needed.

Experiment 17.—A guinea-pig was injected subcutaneously in the groin with a small dose of an agar culture of the Lea River B. coli, and some minutes later a fair dose of vibrio cholerae was injected per peritoneum. The amounts of the two microbes were these:—

Lea River B. coli: One loop of agar growth (two days old) was distributed in about 2 cc. of sterile salt solution, and ½ cc. of this emulsion was injected subcutaneously, *i.e.*, about quarter of a loop of the growth.

Vibrio cholerae: Of a two days' old agar culture about 3 loops were distributed in 2 cc. of salt solution, and 1 cc. of this was injected intraperitoneally, *i.e*, 1½ a loop of the growth.

Next day the animal had a large painful swelling in the groin about the seat of the subcutaneous inoculation; it was also quiet and off its feed. In two days the swelling had extended over the

groin, abdomen, and chest, but the animal was less quiet and fed again a little. After this the tumour decreased and became firmer, and the animal ultimately quite recovered. The experiment, therefore, was a failure as regards vibrio choleræ.

Experiment 18.—On the day on which experiment 17 was undertaken, another guinea-pig was injected with like emulsions of the two microbes, but in this way: a mixture was made with a quarter of a loop of Lea River B. coli and 1 loop of vibrio choleræ, the mixture being injected intraperitoneally.

The animal was found dead in 20 hours. The post-mortem examination showed great inflammation of the peritoneum and abdominal viscera; the sanguineous exudation in the peritoneum yielded on culture abundance of colonies of B. coli; none of vibrio choleræ. Both these experiments (17 and 18) afforded, therefore, none but negative evidence as to B. coli's capacity for enhancing the vibrio.

I nevertheless made a further attempt in the same direction, but with no better result.

Experiment 19.—A mixture of the Lea River B. coli and vibrio choleræ was injected intraperitoneally into a guinea-pig. This mixture consisted of a trace (a fraction of a loop of growth) of the B. coli (agar culture) and a considerable dose (several loops of the growth on agar) of the vibrio choleræ. The animal was quite lively next day and remained altogether unaffected.

I abandoned, therefore, the Lea River B. coli and substituted for it the Ice-cream B. coli, already successfully used in the experiments with B. typhosus.

Experiment 20.—A guinea-pig was injected subcutaneously per axillam with about $\frac{1}{4}$–$\frac{1}{2}$ loop of a four days old agar culture of Ice-cream B. coli. Next day the animal showed much gelatinous swelling about the place of injection, and it was quiet. It received now intraperitoneally a loopful of the growth on agar (48 hours old) of the laboratory vibrio choleræ. A dose far greater than this has on a normal guinea-pig no effect whatever. Next day the animal was moribund.

On post-mortem examination, the peritoneum and viscera were found injected, and there was copious grey viscid fluid in the peritoneal cavity. This fluid contained numerous leucocytes. In film specimens some vibrios are seen in the interior of a few cells, but very few free in the fluid itself. Cultures were made of the peritoneal exudation in peptone salt solution, and good growth of the vibrio choleræ was obtained. An agar surface plate made at the same time with a drop of the peritoneal exudation brought forth four colonies only of vibrio choleræ. The subcutaneous (B. coli) tumour was full of sanguineous fluid containing crowds of the B. coli.

The result of this experiment is therefore quâ vibrio choleræ not satisfactory; for although the peritoneal exudation showed some vibrios after death, possibly injected vibrios that had

survived, there could have occurred no definite increase in the number of the vibrios injected the day previous. The experiment was therefore repeated.

Experiment 21.—A guinea-pig was injected subcutaneously per axillam with a small dose, a fraction of a loop, of the growth Ice-cream B. coli taken from a gelatine surface culture. Next day there was a fair-sized gelatinous swelling about the seat of inoculation. The animal received now per peritoneum one-fifth of a 24 hours' old agar culture of the laboratory vibrio choleræ. A control animal received a like dose of vibrio choleræ per peritoneum.

Next day the "mixture-guinea-pig" was found dead; the control cholera guinea-pig was seemingly unaffected, it remained alive. Post-mortem: there was found in the "mixture" animal great congestion of the peritoneum and viscera; in the peritoneum there was grey viscid exudation containing numerous leucocytes. In stained film specimens of this exudation numerous free vibrios could be demonstrated. Also many of the leucocytes showed vibrios in their interior more or less numerously; some of these vibrios were in small groups, in other cases they appeared degenerating—Pfeiffer's phenomenon. Cultures on agar surface made with a droplet of the exudation yielded abundance of colonies of the vibrio.

This experiment is then clearly of a positive nature, in that subcutaneous injection with the B. coli appears to have enabled the vibrio to multiply in the peritoneal cavity and to become decidedly effective in causing the above pathological changes of the peritoneum.

Several experiments were made with Bacillus Gaertner and with filtrate of the Ice-cream B. coli, each being subcutaneously injected, followed by intraperitoneal injection of vibrio choleræ; parallel experiments, in a word, to those with the B. typhosus mentioned in experiments 6 and 7. The results were, however, wholly negative; no enhancing action on the vibrio followed.

In reference to these experiments with the Lea River B. coli, the Ice-cream B. coli, and B. Gaertner, it would seem that in one instance only (experiment 21) subcutaneous injection of a microbe of the coli group effected a distinct enhancement of the action of the vibrio choleræ. A similar distinctly enhancing action of the Ice-cream B. coli on the B. typhosus was also noted in regard of experiment 5. In this connexion it is of interest to recall the fact that this microbe (the Ice-cream B. coli) has a decided effect on the alimentary canal, inasmuch as when it is introduced into the animal with the food it causes more or less severe gastro-enteritis. Possibly, a similarly active B. coli introduced into the intestine of man might have an important effect in calling forth an enhanced pathogenic effect on any B. typhosus or vibrio choleræ that happened to be ingested along with it.

As with the B. typhosus in Series I., so also with Series II., and the vibrio choleræ, several experiments have been made

with the view of testing the effect of symbiosis with anaërobes, viz., Bacillus (enteritidis) sporogenes and Bacillus carnis.

Experiment 22.—A guinea-pig was injected intraperitoneally with a mixture of ½ cc. of the whey of a 24 hours old typical milk culture of B. sporogenes and ½ cc. of an emulsion of a three days old agar culture of the laboratory vibrio choleræ. The animal was quiet in the evening, but next morning though a little off its feed seemed livelier. In another day it had seemingly quite recovered, and it remained alive.

Experiment 23.—A guinea-pig was injected intraperitoneally with a mixture of ½ cc. of the whey of a 24 hours old typical milk culture of B. sporogenes (the same that was used in experiment 9 and was fatal to a control guinea-pig) and one loop of a three days old agar culture of the laboratory vibrio choleræ. The animal was distinctly ill the same evening and was found dead next morning. Post-mortem: the peritoneum was much congested and there was copious turbid and blood stained peritoneal exudation. Under the microscope this exudation contained numerous, in fact crowds of, Gram-positive B. sporogenes, many in chains and filaments (see experiment 9); and, as well, vibrios. An aërobic agar plate with one loop of exudation yielded abundance of colonies of vibrio choleræ.

As regards the control guinea-pig (mentioned also under experiment 9), this had also been found dead next day with copious chain-like and filamentous enteritidis bacilli in the peritoneal fluid. It follows, therefore, that the death of the "mixture guinea-pig" of this present experiment (22) was due in all probability to the enteritidis milk. Nevertheless the fact remains that the vibrio choleraæ which had been injected at the same time into this animal must have multiplied within the peritoneal cavity, a loop of the exudation having yielded abundance of colonies of the vibrio. I am disposed, therefore, to consider this experiment positive quâ enhancement of vibrio choleræ; that is to say I suspect that the B. sporogenes growing and multiplying actively in the peritoneal cavity did exert an encouraging influence on the vibrio.

Experiment 24.—In this experiment a guinea-pig was injected intraperitoneally with an emulsion of an agar surface culture of B. (enteritidis) sporogenes and one loop of agar growth of vibrio choleræ. This experiment is parallel with experiment 10, in which a mixture of the same agar enteritidis culture in the same dose was injected along with B. typhosus.

The animal injected intraperitoneally with the mixture of enteritidis and vibrio was found dead next morning with the following post-mortem appearances: copious sanguineous turbid exudation containing numerous filamentous B. sporogenes. A Drigalski plate, made with a drop of the exudation, yielded several dozen small deep-blue colonies of typical vibrio choleræ. At the same time that the Drigalski plate was made a pepton

salt tube was also infected with a drop of the exudation. This peptone culture yielded a pure culture of vibrio choleræ, and gave the typical cholera red reaction

It follows, therefore, that in this instance the vibrio choleræ persisted in considerable numbers in the peritoneal cavity, though death of the animal was no doubt due to the action of the enteritidis injection. That the fatal issue is to be ascribed to this cause is indicated by the death of the guinea-pig, which in experiment 10 (made at the same time) was intraperitoneally injected for control with a like dose of the same enteritidis agar culture alone; though, as was stated in reference to experiment 10, it died several hours later than the "mixture guinea-pig."

It is not possible, therefore, to decide whether the persistence of the vibrios in the "mixture guinea-pig" in this instance was caused by a rapid decline of vitality of the guinea-pig (due to enteritidis) some time before all the vibrios injected might otherwise have disappeared, or whether their presence was due to an active multiplication of the vibrios within the peritoneal cavity, as a result directly of the presence of the B. sporogenes. It has to be borne in mind that a full-sized drop of the exudation yielding only several dozen colonies does not point to a very active multiplication; and this result contrasts somewhat with that obtained in experiment 23, where a platinum loop of the exudation yielded abundance of colonies of the vibrio. I therefore am not prepared to affirm that in the animal of experiment 24 there had taken place any active multiplication of the vibrio injected. But I am, I think, at least justified in considering the persistence and demonstration of the living vibrios in the peritoneal cavity after death of the animal as presumptive evidence that many of the vibrios injected had survived as a result indirectly of the presence and activity of the B. sporogenes.

In the next four experiments the symbiotic relation of the vibrio choleraæ was tested with the second anaërobe, B. carnis.

Experiment 25.—In this experiment, which is parallel to experiment 12 (mixture of B. carnis and B. typhosus), a guinea-pig was injected intraperitoneally with a mixture of ½ cc of a milk culture of B. carnis and one-fifth of an agar tube (three days old) of the laboratory vibrio choleræ.

As was mentioned in reference to experiment 12, a control guinea-pig for the B. carnis received intraperitoneally ½ cc. of the same milk culture alone, and remained altogether unaffected. As to the agar culture of the laboratory vibrio choleræ, the amount used in this experiment (25) produces no effect whatever on the guinea-pig, as has been ascertained many times in the course of other, as also of these, experiments.

The result of the injection of the mixture of the two microbes B. carnis and vibrio choleræ in experiment 25 was that the animal was distinctly ill next day and was found dead within 44 hours. On post-mortem examination it showed a large amount of sanguineous turbid peritoneal fluid; intestines dark red, almost gangrenous; liver and parietes of abdominal wall covered with

lumps of solid lymph. Under the microscope both the peritoneal fluid as also the lymph contained great abundance of typical B. carnis (identified in anaërobic culture)—many with terminal spores. Some vibrios also could be recognised in film specimens. With a droplet of the fluid exudation an (aërobic) agar surface plate was made, with the result that it yielded very numerous colonies of the vibrio choleræ.

From this experiment it is therefore clear that, these two microbes which separately produced no effect in their respective controls became capable, nevertheless, when injected together, of multiplying abundantly and causing a fatal issue. Further, it may be assumed from this experiment that the two microbes mutually enhanced each others vitality and power of multiplication, and by implication also their activities.

Experiment 26.—A guinea-pig was injected intraperitoneally with a mixture of ½ cc. of milk culture of B. carnis and about two loops of a 24 hours old agar culture of cholera vibrio. The animal was found dead in 20 hours. This experiment is parallel with experiment 11, in which the B. carnis control guinea-pig, supposed to have been injected intraperitoneally only, died, and was found on post-mortem examination to have suffered from escape, during intraperitoneal injection, of the B. carnis milk into the subcutaneous tissue.

The post-mortem examination of the "mixture animal" of the present experiment showed intense peritonitis, with numerous small masses of solid lymph; some fluid exudation also with numerous leucocytes in it. A Drigalski plate (aërobic) made with a particle of the lymph yielded about one dozen colonies of the vibrio choleræ

I do not consider this a distinct positive result quâ enhancement by B. carnis of the power of multiplication of the vibrio; the animal died too soon. It was quite different in the previous experiment, in which the animal died much later (after 44 hours), and yet, on cultivation, a droplet of the peritoneal exudation yielded very numerous colonies of the vibrio.

Experiment 27 *and Experiment* 28.—In both these experiments, made on two different occasions, minute doses of milk culture of B. carnis were injected on one day subcutaneously per axillam. Next day the guinea-pigs showed gelatinous swelling, but seemed otherwise little affected. They were then injected intraperitoneally with a loop of agar culture of the laboratory vibrio choleræ. In both cases the animals remained alive, and unaffected.

Experiment 29.—This was a repetition of the preceding experiment, viz., a guinea-pig was injected subcutaneously per axillam with a minute dose, few drops, of a nine days old milk culture of B. carnis. Next day the animal showed slight swelling, but otherwise seemed all right. On the following day the swelling had somewhat increased and the animal seemed quiet. It was now injected intraperitoneally with a loopful of a

48 hours old agar culture of the laboratory vibrio choleræ. The day after this peritoneal injection the animal was found very ill, in fact moribund. It was killed, and on post-mortem examination showed sanguineous subcutaneous infiltration containing abundance of B. carnis; the peritoneum was injected and contained a small amount of grey viscid fluid full of leucocytes. A droplet of this fluid inoculated on the surface of a Drigalski plate yielded 34 colonies in pure culture of the vibrio. This may therefore be considered a distinctly positive result as regards the multiplication of vibrio choleræ in the peritoneal cavity.

A last and interesting positive experiment with the cholera vibrio was the following :—

Experiment 30.—A guinea-pig was injected intraperitoneally with a mixture of $\frac{1}{10}$ cc. of a sixteen days old milk culture of B. carnis and one loop of a three days old agar culture of the laboratory vibrio choleræ. Controls were injected intraperitoneally separately for each of the two microbes. Both control animals remained quite unaffected, but the "mixture-guinea-pig" was moribund next day. On post-mortem examination a small amount of turbid viscid exudation containing numerous leucocytes was found present in the peritoneal cavity. A small droplet of this on a surface agar culture yielded numerous colonies of the vibrio.

This then proves that while the control cholera guinea-pig remained unaffected, and by inference no multiplication of the vibrios took place (see the remarks on a former page) in its peritoneum, the other guinea-pig receiving the same dose of cholera culture along with B. carnis suffered an active multiplication of the former microbe, since a droplet of the exudation yielded on culture numerous colonies of this vibrio. From the same exudation an anaerobic agar plate was made; but owing to a slip of the hand when intending to take it out of the incubator its interior became so badly splashed with the fluid pyrogallic that it was lost for inspection.

As a result of these experiments there can, I think, remain no doubt that symbiosis of the vibrio choleræ and the B. carnis has a distinct positive result, inasmuch as hereby the vibrio becomes capable of multiplication in the peritoneal cavity and therefore active. It is at any rate noteworthy that in control animals injected with a like dose in each instance such activity and multiplication of the laboratory vibrio has not been observed.

Series III.

In this series the interaction, within the animal body of the Streptococcus pyogenes and of the Staphylococcus pyogenes aureus on the one hand, and the Bacillus diphtheriæ on the other, was studied in a number of guinea-pigs by intraperitoneal injection. It is common experience that in diphtheritic as also in other throat inflammations the Streptococcus pyogenes and the Staphylococcus pyogenes aureus are present in great numbers in the fauces: in diphtheria in particular the great multiplication of

the Streptococcus in the affected organs of the fauces cannot h help to enhance the severity of the disorder. It was of intere therefore to test this by direct experiment.

Experiment 31.—One-sixth of a five days old agar culture B. diphtheriæ was injected intraperitoneally into control guine pig (*a*); another guinea-pig (*b*) was at the same time injecte with a like dose of the same agar culture of B. diphtheriæ mixe with 0.5 cc. of a two days old broth culture of Streptococc pyogenes recently obtained from the pus of an abscess. A thi guinea-pig (*c*) served as control for this latter microbe, bein injected intraperitoneally with 0·5 cc. of the same broth culture.

Before describing the results of these injections it is necessar to state the following facts concerning the intraperitoneal inje tion into guinea-pigs of B. diphtheriæ and of Streptococc pyogenes.

In my Report for 1895-96, p. 223, I have demonstrated different vulnerability of the guinea-pig to B. diphtheriæ accor ing as this animal is subjected to subcutaneous and to intraper toneal injection. I have there shown that whereas the sul cutaneous injection of a given dose of culture of the bacillus fro a solid medium is productive of the typical fatal disease, intr peritoneal injection of a like dose does nothing of the kind, th animal becoming either only slightly and temporarily (or not a all) affected, and in most cases remaining alive. While such is th rule for instance when $\frac{1}{6}$th of a gelatine culture is used intraper toneally, occasionally, though only in a small percentage instances, it happens that if an agar culture be used instead of gelatine culture the animal sooner or later succumbs. At th time I did not know the cause of this. I am, however, at prese in a position to state that if the culture is on "dry" agar, i. sloped agar without condensation fluid, generally no disease, an in no case fatal result, ensues, whereas if the sloped agar be use of recent make, very moist, and with condensation fluid, $\frac{1}{6}$th such culture causes disease and sometimes death. The cause this difference of action is the absence of diphtheria toxin in th "dry" agar, and its presence in the fluid (moist surface and co densation fluid) of the sloped (moist) agar. And it is owing the absence of such toxin on the gelatine culture (which corr sponds to the "dry" agar) that gelatine culture is, intraper toneally, less active.

In the experiment (31) above-mentioned, and in all subsequen experiments, "dry" agar tubes alone were used; that is to sa sloped agar tubes from which, by keeping them in evaporatin chamber previous to inoculation with B. diphtheriæ, all free flui had been removed.

As regards the Streptococcus pyogenes, this microbe has n effect on the guinea-pig, either subcutaneously or intraperitoneall unless, of course, excessively large doses are used. Such doses I used in these experiments are without effect on the guinea-pi although on mice they act generally fatally.

To return to experiment 31. Both control guinea-pigs, (*a*) and (*c*), were quite unaffected, whereas the "mixture-guinea-pig" (*b*) was found, 24 hours after injection, slightly affected; it was quiet and not feeding well. Forty-eight hours after injection this animal was distinctly more ill. It was now killed and showed on post mortem examination the following appearances. On opening the abdominal cavity numerous hæmorrhages were noticed on the omentum; covering the abdominal wall numerous lumps of lymph were found closely adhering to the capsule of the spleen and omentum. In microscopic film specimens of this lymph bacilli as also streptococci were found between the cells, as also as regards many of them in their interior. In the cavity of the peritoneum there was turbid slightly blood tinged fluid, showing in microscopic specimens blood discs as also leucocytes in considerable number. The small intestine was more or less in an inflamed state. The liver was much congested; on the omentum were several largish lumps of lymph.

Cultures were made:—

(1) of the lymph adhering to the omentum;

(2) of the peritoneal fluid itself; and

(3) of the lymph of the mesentery:—

with the following results:—

(1) the cultures from the lymph of the omentum yielded large number of colonies of B. diphtheriæ, and a relatively limited number of colonies of Streptococcus pyogenes;

(2) the cultures of the fluid exudation yielded a fair number of colonies of both microbes;

(3) the cultures of the lymph of the mesentery yielded crowds of colonies of the Streptococcus pyogenes, and numerous (but less than of the former microbe) colonies of B. diphtheriæ.

For purposes of comparison the two control animals (*a*) and (*c*) were killed at the same time as (*b*), viz., 48 hours after injection. The result of post-mortem in the this case wholly negative; the peritoneal cavity was found normal in both animals.

From this it appears, then, that while the controls remained unaffected, the animal injected with the mixture of B. diphtheriæ and S. pyogenes was affected and showed very decided pathological changes. Also it appears that a distinct multiplication of both the injected microbes had taken place within this animal's body. Hence, though while used singly neither of the two microbes could exist or multiply in the peritoneal cavity, under symbiosis both were enabled to do so.

Experiment 32.—In this experiment, which is similar to the preceding, three guinea-pigs were also used:

(*a*) A control animal for diphtheria, which received intraperitoneally $\frac{1}{12}$th of a 24 hours old agar culture of B. diphtheriæ.

(*b*) "Mixture guinea-pig" which received intraperitone $\frac{1}{12}$th of same diphtheria culture and also $\frac{1}{12}$th of a hours old agar culture of Streptococcus pyogenes.

(*c*) A control guinea-pig for Streptococcus, which recei intraperitoneally the same amount of the culture Streptococcus alone.

The result was that guinea-pig (*a*) (control diphtheria) appea after three days to be quite unaffected, although it seemed to h got thinner; the other two seemed likewise unaffected.

They were all three killed (after three days) and showed following appearances:—

(1) Guinea-pig *a* (control diphtheria): fairly advan pseudotuberculosis of the spleen liver and omentu several lumps of lymph in different parts of mesentery. Cultures of this lymph yielded fa numerous colonies of Bacillus pseudotuberculosis of Bacillus diphtheriæ.

This guinea-pig is not, then, a fair test as control for B. di theriæ; indeed the facts suggest that, being already affected w pseudotuberculosis, the injected B. diphtheriæ found in t animal opportunity of multiplying in its peritoneal cavity.

(2) The guinea-pig *c* (control Streptococcus) appeared norm cultures from different parts of the abdomen remain sterile.

(3) The guinea-pig *b* (mixed infection) showed: turl fluid in the peritoneal cavity, several lumps of lym adhering to the omentum and liver; hæmorrha spots in the capsule of the kidney and in the ser covering of the large intestine; the small intestine parts congested.

Cultures made of a small particle of the lymph of the omentu yielded on the average 11 colonies per agar tube of B. diphtheri none of Streptococcus pyogenes.

This experiment is then fairly confirmatory of previ experience as regards the multiplication of B. diphtheriæ in t peritoneal cavity of the animal injected at the same time wi Streptococcus.

Experiment 33.—In order to make further observations regards Streptococcus pyogenes, and also to ascertain whet the interpretation put on the the facts respecting the cont diphtheria guinea-pig of the previous experiment held go I injected intraperitoneally other three guinea-pigs.

Guinea-pig (*a*) with $\frac{1}{6}$th of an agar culture of B. diphthe (three days old).

Guinea-pig (*c*) with $\frac{1}{6}$th of an agar culture of Streptococ pyogenes, also three days old; and

Guinea-pig (*b*) with a mixture of both microbes—$\frac{1}{6}$th o culture in each instance.

As a result, the two controls (*a*) (*c*) were unaffected and remained so; but the "mixture-guinea-pig" seemed quiet and a little off its feed on the third day, a condition which increased during the next few days, and on the eighth day the animal was found dead.

Post-mortem examination showed the following conditions: The capsule of the liver showed numerous minute grey round points in some places almost confluent; the mesenteric glands were necrotic with caseous matter (diphtheritic) in them, and similar matter adhered to a necrotic patch (diphtheritic ulcer) of the serous layer of the caecum. Both lungs were much congested, and in the pleural cavity were fluid and numerous fibrin threads. Cultures were made of the necrotic matter of the mesenteric gland and of the heart's blood. The cultures of the mesenteric necrotic matter yielded enormous numbers of colonies of B. diphtheriæ in pure culture. Cultures of the heart's blood developed no growth of any kind. That in the necrotic mass no Streptococci were found on the eighth day is probably due to this microbe having been suppressed by the overwhelming multiplication of the diphtheria bacilli that had here taken place.

This experiment is, then, a striking instance of the active multiplication of the diphtheria bacillus and production by it of diphtheritic ulcers in some of the viscera of the peritoneal cavity, into which cavity it had been injected together with the Streptococcus pyogenes.

From these observations it is justifiable to infer that the Bacillus diphtheriæ existing symbiotically with the Streptococcus pyogenes undergoes distinct enhancement and becomes capable of great multiplication while exhibiting definite pathogenicity.

Experiment 34.—One guinea-pig (*a*) was injected intraperitoneally with $\frac{1}{6}$th of a 24 hours old agar culture of Staphylococcus pyogenes aureus obtained recently from an acute abscess.

One guinea-pig (*c*) was injected intraperitoneally with $\frac{1}{6}$th of an agar culture of B. diphtheriæ from a recent fatal case of membranous diphtheria of the fauces in the human subject.

One guinea-pig (*b*) was injected intraperitoneally with a mixture of the above two microbes, $\frac{1}{6}$th of a culture in each instance. The first animal (guinea-pig *a*) remained alive, whereas guinea-pigs *b* and *c* were found dead within 48 hours.

Post-mortem examination of guinea-pig *c* (control diphtheria) showed: sanguineous turbid fluid in the peritoneal cavity; congestion of, and purulent masses adhering to, the omentum. Cultures made from the purulent omentum yielded abundance of colonies of B. diphtheriæ in pure culture.

Post-mortem of the "mixture-guinea-pig" *b* showed: copious turbid fluid in the peritoneal cavity, with lumps of coagulated blood and fibrin; omentum greatly thickened by effused blood and by masses of lymph and pus. Culture of a drop of the peritoneal fluid yielded about five dozen colonies of Staphylococcus

aureus and two colonies of B. diphtheriæ; and two agar tul inoculated each with a particle (one loop) of the pus of t omentum were crowded with almost confluent, apparently pu colonies of Staphylococcus aureus.

No conclusion may perhaps be drawn from this experiment to the B. diphtheriæ. The dose of the culture used having be derived from a recent severe fatal case of diphtheria was doubtl too great, since it proved fatal to the control animal. Inasmu however, as the Staphylococcus control animal did not beco affected, whereas in the "mixture-guinea-pig" the micro-organi in question was found in enormous numbers, it is open to infere that the staphylococcus had multiplied in the peritoneal cav owing to the simultaneous presence there of the B. diphtheriæ. I further experiments are of course required to fully establish th

Summary.

Summarising the results of the preceding experiments, it w I think, be conceded that, allowing for the difficulties inherent the gauging of the dose necessary for the injection, it has be shown that in some instances a real enhancing influence was exer by certain pathogenic microbes—*e.g.*, the Ice-cream B. coli, t B. Gaertner, and particularly the anaërobes B. (enteritid sporogenes and B. carnis—on the B. typhosus, and to a less ext on the vibrio choleræ, under symbiotic conditions in the anim body; and that the same holds good for the Streptococcus pyoger as regards the Bacillus diphtheriæ. But it must be clear th while the general principle has been established for these microl when introduced into the peritoneal cavity, further observatio are required as to the influence of symbiosis of pathogenic microl (indeed also of microbes usually considered non-pathogenic) wh introduced into the body by the alimentary canal and by t respiratory tract. For under natural conditions in many inf tions, as for instance typhoid fever, cholera, dysentery, diphther pneumonia, and other maladies, these two organs are the ch portals of infection, and it is therefore in respect principa of these considerations that further experiments are necessary.

No. 6.

Report on the Toxic Action and on the Reaction of the Toxin of Proteus Vulgaris; by Dr. Sidney Martin, F.R.S.

The experiments which were performed during 1903-04 have had as their object the investigation of the toxic reaction of the chemical products of the Proteus Vulgaris in the animal body. In my Report for the previous year it was shown that this aerobic putrefactive micro-organism formed within its own bacillary body a toxic substance, which was excreted to some extent in the broth in which the bacillus was grown. Although the greater part of the toxin was present in the bodies of the bacillus, the poisonous substances found dissolved in the broth had the same physiological action as the first named toxin. This endo-toxin was closely associated with the proteids; and the other products of the bacillus, such as the organic acids and the foul-smelling bodies, had no very appreciable physiological action.

The physiological action of the toxin injected intravenously in rabbits was shown in an immediate fall of body temperature of several degrees, in the bodily weakness and collapse of the animal, and in the production of numerous and loose motions. This combination of symptoms is common to the endo-toxins of the bacillus coli communis, of the typhoid bacillus, and of the bacillus enteritidis of Gaertner.

Preparation of the Toxin.—The toxin is readily prepared by the methods described in the last Report, namely, either by collecting the bodies of the bacillus from cultures by centrifugalisation, washing them, and drying them, and afterwards extracting with distilled water; or by growing the bacillus in peptone broth for ten to twelve days, and killing the micro-organism by means of chloroform, the chloroform being removed by evaporation before the liquid is used for injection. This broth mixture contains the bodies of the bacillus, as well as some of the endo-toxin which has been excreted. It was this mixture that was used in the experiments to be recorded.

Method of Experimentation.—The broth toxin and the bacillary bodies was injected subcutaneously in repeated doses in rabbits; the object being not to kill the animal, but to produce sufficient symptoms to show that the toxin was active. On the recovery of the animal the effect of its serum as regards (1) Its power of agglutination, and (2) Its antitoxic power was tested.

It was found that the susceptibility of individual rabbits to the effect of the toxin was very variable, even with the same manufacture of toxin, and that this variability did not depend

apparently so much on the weight, as on the characteristics of the individual animal. A large number of experiments was therefore performed in order to test the above reactions of the serum.

Seven rabbits were in all used, the serum of five of which was subsequently tested. Two of these died after comparatively small doses of the toxin.

Experiment I.

A rabbit, weighing 1,870 grammes, received subcutaneously 7 cc. of broth toxin in three doses.

The first two doses, of 2 cc. each, were given within twenty-four hours and produced only a slight rise of temperature.

The third dose of 3 cc. was given eight days after the first dose, and produced also a slight rise of temperature.

Seven days afterwards there was a sudden fall of temperature and death of the animal; and during the whole period there was a progressive loss of weight.

Experiment II.

A rabbit, weighing 1,770 grammes, received two doses subcutaneously of 2 cc. of the toxin, 4 cc. in all, the two doses being given within twenty-four hours. There was a slight fall of temperature and profuse diarrhœa, ending in death in about six days after the first dose.

The remaining four rabbits, from which serum was obtained, were not nearly so sensitive to the action of the toxin, even though they showed some individual variation in susceptibility.

Experiment III.

A rabbit, weighing 1,550 grammes, received five doses subcutaneously, each of 5 cc., of broth toxin, or a total of 25 cc. in the course of fourteen days.

The first dose caused a rise of temperature to 106° F., but no diarrhœa.

The second dose, on the second day, caused a slight fall of the febrile temperature, with a subsequent rise.

The third dose, six days after the first injection, caused no appreciable effect.

The fourth dose, seven days after the first injection, caused a slight fall of temperature, followed by a rise.

The fifth dose, on the twelfth day after the first injection, caused a slight fall of temperature, with a subsequent slight rise, and this dose—unlike the others—produced some diarrhœa.

For the first two days the animal lost 170 grammes in weight, but regained this before the third dose. There was a fall of 80 grammes after the third and fourth doses, and a subsequent rise of 50 grammes. After the last dose the animal lost again 190 grammes; then in the course of three weeks regained its normal weight. Each dose of the toxin therefore had an appreciable physiological action followed by a recovery.

Small quantities of blood were taken before the experiment was begun, and on the first, third, ninth, thirty-first and fortieth days of experiment in order to test the agglutinating power of the serum, and on the fortieth day the animal was killed, and the serum obtained was used for testing its antitoxic power.

Agglutinating Power of Serum.—The agglutinating power of the serum was tested in all the experiments in a similar manner. Dilutions of 1 in 10 to 1 in 1,000, 5,000 and 10,000, were tested with a twenty-four hours' old culture in broth of the Proteus. The testing was done before the experiment, and at different period of the animal's life. From these experiments the following results were obtained :—

Before experiment: Negative in all dilutions.

On the first day (after 1 dose) : Negative in all dilutions.

On the third day (after 2 doses) : Negative in all dilutions.

On the ninth day (after 4 doses) : Positive 1 in 50; partial 1 in 100.

On the thirty-first day (after 5 doses) : Positive in all dilutions up to 1 in 1,000; partial 1 in 5,000.

On the fortieth day : A similar result.

The Antitoxic Power of the Serum.—The serum tested was obtained forty days after the commencement of the experiment. Three rabbits were used; one received the toxin alone, and the other received the same dose of toxin mixed with serum. All the injections were made intravenously.

1. A control rabbit, weighing 1,710 grammes, received 1 cc. of broth toxin intravenously. There was a fall of temperature of 8·5° F. and death occurred in four days, the total loss of weight being meanwhile 320 grammes.

2. A rabbit, weighing 1,700 grammes, received 1 cc. of broth toxin mixed with 0·5 cc. of serum, and injected immediately afterwards, intravenously. There was a fall of temperature of 2° F. followed by a rise of 3°, and a loss of weight in two days of 115 grammes. The animal, however, completely recovered, and weighed three weeks after the experiment 1,800 grammes. It was killed on the twenty-fith day and found to be normal.

3. A rabbit, weighing 1,670 grammes, received 1 cc. of toxin, mixed with 1 cc. of serum, injected immediately after mixing, intravenously. There was a fall of temperature of 1° F. succeeded by a rise of 2°, a loss of weight in two days of 120 grammes, and

subsequent recovery. In twenty-one days the weight was 1,[illegible] grammes. The animal was killed in twenty-five days and found to be normal.

In these experiments the serum of the rabbit treated with th broth toxin showed a well marked agglutinating power, but als apparently a definite antitoxic power, that is, the serum mixe with the toxin diminished, although it did not prevent all th symptoms of the toxic action, and the animals recovered, whil the control animal died.

Experiment IV.

A rabbit, weighing 1,730 grammes, received, like the animal i Experiment III, five injections of proteus broth toxin subcuta neously, each of 5 cc., a total dose of 25 cc.

The first two injections, within twenty-four hours of eac other, caused only a slight rise of temperature, with slig diarrhœa.

The third and fourth injections, on the seventh and eighth da respectively, caused a rise of temperature and no diarrhœa.

The fifth injection, on the thirteenth day, caused a slight rise temperature.

The total loss of weight during the period of the injections w 200 grammes, and subsequently, after fluctuations, the anim gained 270 grammes in weight. It died in seventy-nine day and no lesion was found in the organs.

Agglutinating Action of the Serum.—Before the experime a slight reaction was obtained in a dilution of 1 in 10, but not greater dilutions.

On the fourth day (after 2 doses) there was a partial reaction 1 in 100.

On the eleventh day (after 4 doses) there was a positive reacti of 1 in 100.

On the fifteenth day, that is after the fifth injection, there w a rapid rise in the agglutinating power of the blood, as th reaction of 1 in 1,000 was complete, and of 1 in 5,000 partial.

On the fiftieth day there was also a partial reaction of 1 10,000.

Antitoxic Action of Serum.—The animal was bled from a vess of the ear on the fifty-fifth day to test the antitoxic power of th serum. Two experiments were performed :—

A rabbit, weighing 2,130 grammes, received 2·25 cc. of toxi mixed with 9 cc. of serum. There was a fall of temperature o 5° F., followed by a slight rise. The total fall of weight wa 250 grammes, but the animal subsequently recovered both weigh and general appearance, and was killed in twenty-eight days.

A control rabbit, weighing 2,220 grammes, received intravenously the same dose of toxin as the first rabbit, namely, 2·25 cc., mixed with 9 cc. of normal saline solution. There was a fall of temperature of 2°, followed by a slight rise, and loss of weight of 290 grammes. The animal subsequently recovered both weight and appearance, and was killed in twenty-eight days.

No further experiments were done with this serum.

The experiment recorded has no particular value regarded as a test of antitoxic power, inasmuch as the toxin diluted with saline solution produced a less effect than that diluted with serum. The toxin was probably not highly toxic, and the individual susceptibility of the animal must be taken into account.

Experiment V.

A rabbit, weighing 2,500 grammes, received 10 cc. subcutaneously of proteus toxin in four doses, two of 2 cc. and two of 3 cc.

After the first two doses, given on the first and second days, there was a slight fall of temperature, but no diarrhœa.

After the third dose on the eighth day there was a slight rise of temperature, followed by a fall during the succeeding days.

After the fourth dose, on the twenty-second day, there was but little effect on the temperature.

The weight of the animal fell gradually after the first three doses, the loss amounting altogether to 250 grammes. After the fourth dose there was a slight fall of weight, but the animal subsequently gained more than its original weight, and completely recovered.

This experiment differs from Experiments III. and IV., inasmuch as smaller doses of the toxin were given, and at much longer intervals.

Agglutinating Action.—Before the experiment, the reaction was negative in 1 in 30 and 1 in 100.

On the eighth day (after two doses) it was positive in 1 in 25 and 1 in 100; negative in 1 in 1,000.

On the fourteenth day (after three doses) it was positive in 1 in 100 and partial in 1 in 500.

In twenty-one days (after three doses) it was positive in 1 in 500 and partial in one in 1,000, and on subsequent days the testing did not show that the agglutinating power rose above this.

Antitoxic Power of Serum.—The serum was obtained by bleeding from the ear on the fiftieth day of experiment, twenty-eight days after the last injection.

1. A rabbit, weighing 1,230 grammes, received intravenously a mixture of 5 cc. of the toxin and 5 cc. of saline solution. Death occurred in three-quarters of an hour, in collapse.

2. A second rabbit, weighing 1,230 grammes, received 5 cc. toxin and 5 cc. of serum, the mixture being allowed to stan one hour before injection. The animal died immediately afte the injection with convulsive movements.

3. A third rabbit, weighing 1,340 grammes, received the sam dose of toxin and serum as the last rabbit, but the mixture wa allowed to stand two hours instead of one. The animal die suddenly before the injection was completed.

It might be considered in this experiment that the serum instead of preventing the action of the toxin, actually reinforce its action, inasmuch as those animals that received the serum an toxin died more rapidly than the one that received the toxi alone. This, however, would not be a legitimate conclusion fro this single experiment, inasmuch as rabbits do die most unaccount ably in convulsions after intravenous injection, even of a clea liquid.

Experiment VI.

A rabbit, weighing 2,390 grammes, received 16 cc. of proteu toxin in six doses, two of 2 cc. and four of 3 cc.

The first two doses (2 cc.) each caused a slight rise of temperature and no diarrhœa.

The third dose, on the eighth day, also caused a slight rise o temperature.

The fourth dose, on the fourteenth day (3 cc.) had the sam effect.

The fifth dose, on the eighteenth day, had no appreciable effec

The sixth dose, on the twenty-second day, caused a slight ris of temperature.

There was no diarrhœa at any time, and the total loss of weigh was 270 grammes. The animal subsequently recovered, both i appearance and weight.

Agglutinating Power of Serum.—Before the experiment th serum gave no reaction in dilutions of 1 in 30 or 1 in 100.

On the eighth day (after two doses = 4 cc.) a dilution of 1 in 5 was positive ; 1 in 100 partial.

On the fifteenth day (after four doses = 10 cc.) a dilution o 1 in 100 was complete ; 1 in 500 nearly complete; 1 in 1,00 partial.

On the twenty-second and subsequent days 1 in 500 wa complete, and 1 in 1,000 partial.

Antitoxic Power of Serum.—The animal was bled on two occasions, on the forty-fourth day of the experiment (twenty-first day after the last injection) and on the seventy-second day of experiment (forty-nine days after the last injection).

Serum of the Forty-fourth Day of Experiment.—A rabbit, weighing 1,250 grammes, received 5 cc. of proteus broth toxin, mixed with 5 cc. of the serum, and the mixture was allowed to stand for one hour before being injected intravenously. There was an immediate fall of temperature of 4° F., with a subsequent rise to the normal, but the animal died in twenty days in collapse, with diarrhœa and a fall of temperature of nearly 8°, the total loss of weight being 190 grammes. These are the symptoms of the action of proteus toxin.

A second rabbit, weighing 1,600 grammes, received the same dose of toxin and serum, the mixture being kept two hours before being injected, instead of one hour, as in the previous experiment. There was a fall of temperature of several degrees, and death in under three hours.

These two experiments show no antitoxic action of the serum, and also demonstrate the irregular action of the proteus toxin in rabbits of nearly equal weight.

Serum of the Seventy-second Day of Experiment.—Experiments were made with this serum to test the toxic action of the serum by itself, and the effect of the serum mixed with the toxin.

A rabbit, weighing 1,900 grammes, received 5 cc. of serum, mixed with 5 cc. of saline solution. There was a very slight rise of temperature and no effect on the weight. The animal recovered.

A rabbit, weighing 1,920 grammes, received 5 cc. of toxin, mixed with 5 cc. of saline solution. This was followed by some diarrhœa and a fall of temperature of 3°, followed by a rise, and there was a loss of weight of 240 grammes. The animal subsequently recovered, and was killed twenty-two days afterwards.

The three following animals received the same dose of toxin (5 cc.) and the same dose of serum (5 cc.), mixed before injection :—

A rabbit, weighing 1,240 grammes, received the dose intravenously immediately after mixing. The temperature fell over 7° F. in two hours ; there was diarrhœa, and death occurred in five and a half hours.

A second rabbit, weighing 2,000 grammes, received the same dose, which was mixed one hour before injection. There was some lowering of temperature, slight diarrhœa, and rapid respiration. The animal, however, recovered, and was killed twenty-two days afterwards.

A third rabbit, weighing 1,420 grammes, received the same dose of toxin and serum, which was allowed to stand two hours before injection. There was a fall of temperature of nearly 7° F. rapid respiration, and death in one and a half hours.

In these three cases the serum did not appear to have any antitoxic action. The animal that survived was a large one, and its greater vigour would perhaps explain its survival and the action of the toxin.

Two more animals were injected with a mixture of toxin, sal solution, and serum.

A rabbit, weighing 1,780 grammes, received 2 cc. of toxin, 3 of saline solution, and 5 cc. of serum, mixed and allowed to sta one hour. The animal was made very ill, the temperature fe but recovery took place, and the animal was killed twenty-t days afterwards.

A rabbit, weighing 1,200 grammes, received 5 cc. of toxin, 3 of saline solution, and 2 cc. of serum, allowed to stand one ho after mixing before injection. The animal died in ten minutes convulsions.

The experiment shows that the serum itself has no toxic acti in the dose given, and that the effect of a mixture of toxin a saline, of toxin and of serum, and of toxin, saline and serum depends in this instance on the amount of toxin given and weig of the animal to some extent, and on its individual susceptibili

Experiment VII.

A rabbit, weighing 1,430 grammes, received like the one Experiment VI., 16 cc. of proteus toxin in six doses, two of 2 and four of 3 cc.

The first two doses, given within 24 hours, produced a slig rise of temperature, but no diarrhœa.

After the third dose, on the eighth day, the rise of temperatu was very little.

The fourth dose, on the thirteenth day, produced but lit effect.

The fifth dose, on the seventeenth day, also had no effect.

And the sixth dose, on the twenty-first day, produced no obvio effect.

The weight increased 50 grammes after the first two doses, b then gradually diminished, and its greatest fall was six days aft the last dose, when the total loss of weight was 130 gramm The animal then gained weight, and was eventually over 4 grammes above its initial weight.

Agglutinating Power of Serum.—Before the experiment the was a negative reaction in dilutions of 1 in 30 and 1 in 100.

On the ninth day there was a positive reaction in dilutions 1 in 50 and a partial reaction of 1 in 100.

On the fifteenth day in addition to the above a dilution of 1 500 gave a partial reaction.

On the twenty-second and twenty-ninth days there was positive reaction in dilutions of 1 in 1,000, and the reaction of 1 5,000 was nearly complete and the reaction of 1 in 10,000 w partial.

Antitoxic Power of Serum.—The animal was bled on three occasions; on the thirty-fifth, forty-seventh, and seventy-fourth days of experiment.

1. *Serum obtained by the First Bleeding*, thirty-fifth day of experiment, fifteen days after the last injection.

A control rabbit, weighing 1,360 grammes, received 5 cc. proteus toxin and 5 cc. saline solution intravenously. The temperature fell 5° F. in five hours, and the next morning had fallen 2° more, and it remained at this level, with slight variations, till the third day, when the animal died. No diarrhœa was produced.

A rabbit, weighing 1,660 grammes, received 5 cc. of proteus toxin and 5 cc. of serum, injected immediately after mixing. Diarrhœa was produced and the temperature fell nearly 7°, the animal dying within twenty-four hours.

A rabbit, weighing 1,480 grammes, received 5 cc. of proteus toxin and 5 cc. of serum, the mixture being allowed to stand one hour before injection. The temperature fell slightly, and the loss of weight in six days was 380 grammes. Subsequently the weight was regained and the animal remained well. It was killed thirty days afterwards.

In the second of these animals it does not appear that the serum had any effect on the action of the toxin. It might possibly have intensified the action. This deduction, however, cannot be made in view of the result of the third animal, where the same amount of mixture, allowed to stand one hour, produced practically no toxic symptoms except loss of weight. The animals used did not vary very much in weight, and the discordant results may probably best be ascribed to individual peculiarity of the animals.

2. *Serum obtained by Bleeding on the Forty-Seventh Day of Experiment*, thirty-seven days after the last injection.

A control rabbit, weighing 1,810 grammes, received intravenously 5 cc. of Proteus toxin mixed with 5 cc. of saline solution. Profuse diarrhœa was produced, the temperature fell over 3° F., and there was a loss of 230 grammes in weight in twenty four hours. Subsequently the animal recovered and was killed in thirty days.

A rabbit, weighing 1,900 grammes, received 5 cc. of Proteus toxin and 5 cc. of serum, the mixture being allowed to stand one hour. Death occurred immediately after the injection in convulsions.

A rabbit, weighing 1,410 grammes, received the same dose as the last, the mixture not being allowed to stand. The animal died immediately after the injection.

In the two last experiments death might be ascribed to that accidental death which occurs in certain rabbits from any form of intravenous injection. Sudden death has occurred more frequently in this series of experiments than in any I have previously done, and would appear to suggest that the serum mixed with the toxin

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in some way reinforced its action. Yet the serum itself in the doses given is not toxic. An experiment of this kind was described in the last experiment.

With this serum a rabbit, weighing 1,060 grammes, was injected intravenously, 5 cc. of the serum mixed with 5 cc. of saline solution. Beyond a minimal rise of temperature no effect on the rabbit was observed.

3. *Serum obtained by Bleeding on the Seventy-fourth Day of Experiment*, fifty-four days after the last injection.

The experiments with this serum were done with rather smaller doses both of serum and of toxin.

Two control animals received toxin alone.

A rabbit, weighing 1,370 grammes, received intravenously 0·25 cc. Proteus toxin and 0·25 cc. of saline solution. Diarrhœa was produced, and an irregular temperature, with slight loss of weight. Recovery ensued, and the animal was killed ten days afterwards.

A rabbit, weighing 1,520 grammes, received exactly the same dose of toxin. There was a slight rise of temperature, but no diarrhœa, and a loss of weight of 140 grammes. The animal recovered, and was killed in ten days.

Four animals were used for testing the action of the serum. Each animal received 0·25 cc. of toxin. In addition two animals received 2 cc. of serum and two received 4 cc.

A rabbit, weighing 2,120 grammes, which received 0·25 cc. of toxin and 2 cc. serum, injected at once, showed a fall of temperature and a loss of weight of 70 grammes. Recovery took place.

A rabbit, weighing 2,200 grammes, which received 0·25 cc. toxin and 2 cc. serum, injected one hour after mixing, showed a slight rise of temperature and a gain of weight of 150 grammes in ten days with recovery.

A rabbit, weighing 1,970 grammes, which received 0·25 cc. toxin and 4 cc. serum, injected immediately after mixing, showed a slight rise of temperature and no variation in weight. Recovery took place.

A rabbit, weighing 1,750 grammes, which received 0·25 cc. toxin and 4 cc. of serum, injected one hour after mixing, showed a slight rise of temperature and a loss of weight of 130 grammes in ten days.

From these experiments it does not appear that the serum had any appreciable effect on the action of the toxin.

After the last bleeding in this animal of Experiment VII., the rabbit was injected with 1 cc. of Proteus toxin intravenously, an amount which had been shown in other animals to have a

profound toxic effect. It produced in this animal diarrhœa and a fall of temperature, so that the rabbit was not immune at this period against the toxin.

In summing up these experiments, it is obvious that, besides the toxic effect of the Proteus toxin, which has been fully described in the last Report, the toxic reaction is mainly shown in the development of an agglutinin in the blood. This agglutinin is formed fairly rapidly, and in comparatively large quantities. The Proteus toxin therefore in this respect behaves like the toxins of the Coli and typhoid groups of organisms. No very clear indication was obtained of any large formation of antitoxin by the injection of the Proteus toxin into rabbits. Some of the experiments apparently show that the serum of these treated animals does have some slight antitoxic power, but this is not constant in all the treated animals, and the antitoxin effect of the serum appears to be as irregular as the toxic effect of the toxin.

Still more doubtful than the antitoxic action is the question of the reinforcement of the action of the toxin by the serum of the of the treated animals. It was thought at one time that this was quite an obvious result, but further investigation showed that this interpretation might not be a correct one.

More work is necessary to determine under what conditions, if any, in rabbits the Proteus toxin can give rise to an antitoxin, and it may be that in other animals the effect would be different to that observed in the experiments with the rabbits.

No. 7.

Report on the Bacteriological Examination of (1) the Normal Stools of Healthy Persons; (2) the Intestinal Contents of Sea-fowl and Fish; and (3) Certain of our Public Water Supplies; by Dr. A. C. Houston.

Last year (1902–3) I reported on the bacteriology of (1) the Tunbridge Deep Well Waters (Appendix B, No. 6), and (2) the Evacuations of the Human Intestine (Appendix B, No. 5).

It is desirable to summarise these two reports of last year very briefly, as the results obtained have an important bearing on the investigations carried out during 1903-4.

TUNBRIDGE DEEP WELL WATERS.

As regards the Tunbridge deep well waters (Appendix B, No. 6), the results showed that B. coli or coli-like microbes may be either absent from a deep well water or detectable only occasionally, and then only when submitting to cultural tests a large volume of the water. Moreover, none of the coli-like microbes isolated from the samples of water resembled in their biological attributes at all closely the *classical* B. coli which was found to be present in overwhelming abundance in the fresh fæces of healthy persons (Appendix B, No. 5). Similar negative results were obtained in the case of the B. enteritidis sporogenes and streptococcus tests.

The Tunbridge wells it should be noted are not only deep wells, but draw their supply from a virgin area (Ashdown sands).

The results at Tunbridge were thus very different from those obtained in connexion with the shallow wells at Chichester.

In the report under summary the opportunity was taken of comparing critically the results obtained in the case of the bacteriological examination of (1) deep wells deriving their water from virgin sources; (2) shallow wells sunk in polluted soil; (3) sewage and sewage effluents; and (4) fresh human fæces. Numbers (1) and (4) constitute respectively the two extremes or poles, and the remarkable distinction which can be shown to exist between pure water and the evacuation of the human intestine by accurate qualitative and quantitative bacteriological methods was used as a basis for claiming that the bacterioscopic analysis of potable waters may be of fundamental importance. At the same time the point was not lost sight of that the presence in drinking water of microbes undistinguishable from those of intestinal outcome is merely an indication of potential danger to health, and in no sense measures the "disease value" of a given pollution.

Bearing this circumstance and other crucial difficulties in mind, the main purpose of last year's report was to make available for future reference such detailed records as might, in conjunction with the observations of fellow-workers and when judged by the test of experience, help eventually to link together the observations of the chemist, the bacteriologist, the topographist, and the epidemiologist in connexion with water supply.

It was indeed felt at the time of writing the report that there was such a dearth of available bacteriological records as regards water supply that no critical survey from the standpoint of epidemiological experience could possibly be attempted.

The absence of correlation of bacteriological facts with epidemiological experience stands at present in the path of progress in this important field of inquiry.

NORMAL HUMAN FÆCES.

As regards the report on the bacteriology of human fæces (Appendix B, No. 5), it will only be possible to consider here some of the main facts obtained during the investigation.

The following is a brief statement of the average results :—

Average results stated as Number per gramme of Fæces.	
Test (1).—Total number of bacteria (gelatine at 20° C. and agar at 37° C.).	100 million, not 1,000 million.
„ (2).—Spores of aërobic bacteria	1,000, not 10,000.
„ (3).—B. coli	100 million, not 1,000 million.
„ (4).—Streptococci	At least 100,000 (probably an under-estimate).
„ (5).—B. enteritidis sporogenes test ..	1 million, not 10 million.
„ (6).—Virulence of B. enteritidis sporogenes, cultures (rodents).	1 million, not 10 million (? 100,000 a safer estimate).
„ (7).—Virulence of broth cultures (rodents).	10 million, not 100 million.
„ (8).—Indol test	100 million, but less than 1,000 million.
„ (9).—Lactose, peptone, milk test.. ..	
„ (10).—Bile-salt, glucose, peptone test ..	
„ (11).—Neutral-red broth test	

Owing to the overwhelming abundance of B. coli in fæces it was not surprising to find that on the average the figures for tests (1), (3), (8), (9), (10), and (11) were practically identical.

As regards test (2), it should be noted that the number of spores of aërobic bacteria was relatively small in contrast with the results I have previously recorded as regards soils.

In respect of test (4), subsequent work with different media leads me to regard 100,000 streptococci per gramme of fæces as probably an under-estimate. It is quite certain that in some samples of fæces the streptococci may exceed B. coli in number. 91 per cent. of the streptococci formed short to medium chains in broth cultures; of these the majority formed short chains. 85 per cent. produced uniform turbidity in broth cultures. 81 per cent. produced acid clotting in milk cultures. Practically all the streptococci were either non-pathogenic to mice or their pathogenicity was open to some degree of doubt.

As regards tests (5) and (6), so virulent were the milk cultures showing the "enteritidis change" that it might almost be said that on the average the two sets of figures were identical. But a safer estimate would be to divide the figures for the B. enteritidis sporogenes test by ten, in order to arrive at the figures for the number of spores of this anaërobe present in fæces in virulent form.

The extreme virulence of broth cultures (test 7) seeded with infinitesimally small amounts of fæces was a striking feature of the analyses. The explanation might be sought for in the presence of (1) the spores of aërobic and anaërobic bacteria, (2) B. coli, and (3) streptococci. But the number of spores seemingly of anaërobes—certainly of aërobes—were too few to admit of their being readily accepted as the causal agents. Further, as regards B. coli, but a small percentage of the B. coli isolated and inoculated into rodents in pure culture proved virulent. It has already been pointed out that the streptococci were practically non-pathogenic. Possibly the mixture of coli or of streptococci or of both classes of microbes in the broth cultures were responsible for the results observed as regards virulence.

In respect of test (3) most work was done, and this work took the form of an attempt to link together on a comprehensive basis the numerical abundance of biological attributes of B. coli in faeces. About 100 specimens of B. coli were investigated. Their numerical abundance per gramme of faeces may be summed up as follows :—

10,000	million	in	four	per cent. of the samples.
1,000	„	„	six	„ „
100	„	„	nine	„ „
10	„	„	sixteen	„ „
1	„	„	twenty	„ „
100	thousand	„	twenty-four	„ „
10	„	„	fourteen	„ „
1	„	„	eight	„ „

The percentage number of B. coli giving a positive result with each separate test was as follows :—

Tests.	Percentage Number.
Motility	99
"*Gas*" *in gelatine* "*shake*" *cultures*	100
Acid and gas formation, glucose peptone medium	100
Acid and gas formation, lactose peptone medium	92
[*Cane-sugar peptone medium, negative or atypical results*]	(93)
[*Dulcit peptone medium, acid or bleached appearance, with gas formation*]	(55)
Neutral red broth, greenish-yellow fluorescence	98
Indol test (indol in broth cultures)	96
Litmus milk cultures (*acid and clot*)	93
Lactose, peptone, sodium carbonate, milk medium (*gas, acid, and clot*)	90
Nitrate broth (*reduction of nitrates to nitrites*)	100
Proskauer and Capaldi Medium No. I. (*bright cherry red colour within* 24 *hours*)	98
Proskauer and Capaldi Medium No. II. (*bleached appearance, no definite acidity*)	100
Litmus whey cultures (26 *to* 46 *per cent.* $\frac{N}{10}$ Na_2CO_3 *to neutralise the acidity*)	98
[*Virulence in broth cultures* (*death of rodent within* 48 *hours*)]	(8)
[*No liquefaction of gelatine*]	(100)

A safe estimate would be that at least 90 per cent. of the coli-like microbes investigated were so markedly positive in their attributes that, practically speaking, they could not be regarded as other than typical B. coli.

All the B. coli were submitted to agglutination tests with—

(1) Anti-typhoid guinea-pig serum.

(2) Anti-typhoid Berne serum.

(3) Serum of person supplying B. coli from faeces.

(4) Serum of person *not* supplying B. coli from faeces.

As regards sera (1) and (2), only a very small proportion of the B. coli were agglutinated. In respect of sera (3) and (4), the proportion of B. coli agglutinated was greater, but it seemed as if these microbes were as readily "clumped" with the serum of persons *not* supplying the B. coli as with the serum of the individuals from whose faeces the microbes were originally derived.

During the current year (1903–4) the investigations have covered a wide field, and it will be necessary to consider the work under three main divisions.

DIVISION I.

*The Bacteriological Examination of the Stools of Healthy Persons.**

Last year (1902–3) I reported very fully on the numerical abundance and biological attributes of the typical B. coli of fresh human fæces. This year it was sought to investigate the characters of the atypical (non-lactose fermenting) varieties of B. coli. As a matter of fact but little progress has been made, *in a positive sense*, in this direction owing to the overwhelming preponderance of the typical forms of B. coli.

Again, by last year's work it was shown that broth cultures inoculated with often infinitesimally small amounts of fresh human fæces were after incubation at 37° C. for 48 hours usually highly virulent in rodents. This result was the more remarkable since B. coli isolated in pure culture from, generally speaking, *parallel amounts* of fæces proved in the great majority of cases to be non-virulent. This year some experiments were carried out with the object of throwing some light on the cause of the virulence of broth cultures of fresh human fæces. Some further experiments were also carried out as regards the indol test.

Lastly, although in last year's work the streptococci were specially investigated, it was considered that a much more prolonged investigation of these micro-organisms was necessary before even tentative conclusions could be drawn. Accordingly during the current year no less than 300 streptococci have been made the subject of special study. Work in this direction was rendered more useful in view of certain observations of my colleague Dr. Gordon. He, in a preliminary but laborious piece of work, had already tested multiple strains of streptococci derived from various sources in a large number of liquid sugar and other media. As a result of this investigation he was able to discard as media certain sugars (and alcohols) and to accept others as likely to prove of practical value in the differentiation by culture of streptococci. In the accepted group he at the time included salicin, saccharose, lactose, mannite, inulin and raffinose, employing them in conjunction with neutral red broth (anaërobically) and litmus milk. The "change" produced by the micro-organisms in the sugar media is not, of course, one of gas formation but of acidity, as evidenced by reddening of the litmus-tinted media.

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* Unless otherwise stated the methods adopted were the same as those practised during 1902–3.

It will be convenient to consider the results under Division I under the following headings :—

A. The atypical varieties of B. coli in fæces.

B. The cause of the virulence of broth cultures inoculated with minute traces of fæces.

C. Further experiments as regards the indol test.

D. The numerical abundance and biological attributes of streptococci in stools.

E. The vitality of fæcal streptococci.

F. Prospective value of the streptococcus test.

A. *The Atypical (non-lactose fermenting) Varieties of B. coli in Human Fæces.*

In studying this question it was thought advisable to use Drigalski's and Conradi's medium, and to discard all microbes fermenting lactose.

Experiment I., Fæces I.—In this experiment plates were inoculated severally with (*a*) $\frac{1}{100000}$, (*b*) $\frac{1}{1000000}$, (*c*) $\frac{1}{10000000}$, and (*d*) $\frac{1}{100000000}$ of a gramme of fæces. From the (*b*) plate 25 colonies were subcultured in lactose peptone medium. These were not necessarily "blue" colonies, but the "least red" (if such a term is permissible) amongst all the colonies in the particular plate, out of a series of plates, which showed a "workable number" of separate growths. With the exception of colonies 1 and 19 all the subcultures formed acid and gas in the lactose peptone medium (*see* Table I.)

Experiment II., Fæces II.—The procedure was exactly the same as in Experiment I, but the result was different. In this stool the streptococci or pseudo-streptococci altogether outvied in number B. coli. Even in the (*a*) plate ($\frac{1}{100000}$ gramme of fæces) no coli were encountered, and hence no subcultures were made.

Experiment III., Fæces III.—The procedure was again the same as in Experiment I. From the (*b*) plate ($\frac{1}{1000000}$ gramme of fæces) eleven subcultures were made into lactose peptone medium. All gave acid and gas, and so were forthwith discarded.

Experiment IV., Fæces IV.—The procedure was the same as in Experiment I. No subcultures, however, were made, as only the (*a*) and (*b*) plates showed coli colonies, and the growths had spread over the surface of the plates in such a manner as to make it undesirable to resort to subculture.

Experiment V., Fæces V.—The procedure was the same as in Experiment I. The plates, however, proved too dilute. Nevertheless two coli-like colonies occurring in the lowest dilution plate (*a*) were subcultured in lactose peptone medium. Both formed acid and gas and so were discarded.

Experiment VI., Fæces VI.—The procedure remained the same. 12 colonies from the (*c*) plate ($\frac{1}{10000000}$ gramme of fæces) were subcultured in lactose peptone medium. All formed acid and gas, and were discarded in consequence.

Experiment VII., Fæces VII.—The procedure remained the same. From the (*b*) plate ($\frac{1}{1000000}$ gramme of fæces) 12 subcultures were made into lactose peptone medium. But all the cultures formed acid and gas.

Experiment VIII., Fæces VIII.—The procedure remained the same. 100 subcultures were made in lactose peptone medium, 80 from the (*a*) plate ($\frac{1}{100000}$ gramme), 17 from the (*b*) plate ($\frac{1}{1000000}$ gramme), and 3 from the (*c*) plate ($\frac{1}{10000000}$ gramme of fæces). All the cultures formed acid and gas with the exception of four taken from the (*a*) plate (*see* Table I.).

Experiment IX., Fæces IX.—The procedure remained the same. 16 subcultures were made in lactose peptone medium from the (*c*) plate ($\frac{1}{10000000}$ gramme of fæces). All gave acid and gas.

Experiment X., Fæces X.—The procedure remained the same. 20 subcultures were made in lactose peptone medium from the (*a*) plate ($\frac{1}{1000000}$ gramme of fæces) All gave acid and gas.

Experiment XI, Fæces XI.—The procedure remained the same. The plates proved too dilute for practical purposes, hence no subcultures were made into lactose peptone medium.

Experiment VII., Fæces VII—Same remarks as under Experiment XI.

Experiment XIII., Fæces XIII. Same remarks as under Experiment XI.

Experiment XIV., Fæces XIV.—The procedure remained the same. 20 lactose peptone cultures were made from the (*b*) plate ($\frac{1}{10000000}$ gramme of fæces). All gave acid and gas, and so were discarded.

Experiment XV., Fæces XV—The procedure remained the same. 20 lactose peptone cultures were made from the (*b*) plate ($\frac{1}{10000000}$ gramme of fæces). All gave acid and gas, and so were rejected.

Experiment XVI., Fæces XVI.—Same remarks as under Experiment XI.

Experiment XVII., Fæces XVII.—The procedure remained the same. Five subcultures were made in lactose peptone medium: four from (*a*) plate ($\frac{1}{1000000}$ gramme) and one from (*b*) plate ($\frac{1}{10000000}$ gramme of fæces). All gave acid and gas.

Experiment XVIII., Fæces XVIII.—The procedure remained the same. 14 lactose peptone cultures were made from the (*a*) plate ($\frac{1}{1000000}$ gramme of fæces). All gave acid and gas.

Experiment XIX., Fæces XIX—Same remarks as under Experiment XI.

In summary of the foregoing all that need be said is that *out 257 colonies isolated from 12 stools no less than 251 produced acid and gas in lactose peptone medium.* As regards the remaining six (about 2·34 per cent. of the whole) colonies which did not ferment lactose, their attributes are set forth in the accompanying table (Table I.) On the basis of these experiments it would seem that in the normal stools of healthy persons atypical *non*-lactose-fermenting coli-like microbes are much fewer in number than typical lactose-fermenting B. coli.* This need not, however, be true as regards the stools of diseased persons, the dejecta of the lower animals, and even the evacuations of healthy persons fed on special diet.

In last year's work (1902–3) 92 per cent. of the coli-like microbes isolated from normal human fæces fermented lactose typically. 5 per cent. gave feebly positive results. Only 3 per cent. gave quite negative results.

There can be no question that to accept the presence in a water sample of non-lactose fermenting coli-like microbes as, by itself, indication of potentially dangerous fouling of a water supply involves a considerable element of responsibility. But the degree of responsibility to be incurred is not easy to gauge in the absence among other things of adequate knowledge of the life-history of all the coli-like microbes primarily of intestinal origin but continuing their existence under saprophytic conditions. It seems at all events certain on the basis of last year's work that, whereas in fresh human fæces over 90 per cent. of the coli-like microbes which ferment glucose also ferment lactose, in waters *known* to be sewage-polluted the

* It needs, however, to be remembered that a microbe may be present in a stool in considerable number, but that its presence may be "masked" by the overwhelming preponderance of other bacteria. In such a case unless some selective medium is known and used or recourse had perhaps to animal inoculation as a "sifting process" the microbe in question may easily be overlooked. It is, indeed, apt to be characteristic of bacteriological work that the many attract attention to the exclusion of the few.

number of glucose fermenting but non-lactose fermenting bacte is proportionately greater. It is easy to say that the gluc fermenting but non-lactose fermenting microbes should ignored as evidence of undesirable pollution. Yet the f remains that glucose fermenting bacteria *of any sort* are co monly absent from 100 or more cubic centimetres of such wa as is remote from the possibility of objectionable pollutic Nevertheless, although certain glucose fermenting *and* lact fermenting coli-*like* microbes appear to have little or no cla to be associated with *recent* human intestinal pollution,* t absence of ability to ferment lactose as well as glucose affor generally speaking, special presumption of the absence of u desirable fouling of a water supply.†

Table I.

Showing the results of subculture of 257 coli-like microb isolated from normal human faces with the view of studyi the biological attributes of the atypical non-lactose-fermer ing varieties.

Description of the coli-like microbe.	Lactose peptone cultures (48 hours at 37° C.).	Proskauer and Capaldi's medium No. I. (24 hours at 37° C.).	Proskauer and Capaldi's medium No. II. (24 hours at 37° C.).	Neutral red broth cultures (48 hours at 37° C.).	Indol in broth cultures (5 days at 37° C.).	Litmus milk cultures (5 days at 37° C.).	Gelatine shake cultures (24 hours at 20° C.).	Glucose peptone cultures
No. 1.—Isolated from $\frac{1}{1000000}$ gramme, stool I.	No gas.	No visible change.	Growth and distinct acidity	Greenish yellow fluorescence.	Negative	Acid, no clot.	No gas.	N ga
Nos. 2 to 18.—Isolated from $\frac{1}{1000000}$ gramme, stool I.	Acid and gas.	As all these microbes formed acid and gas in lac peptone cultures they were not studied further.						
No. 19.—Isolated from $\frac{1}{1000000}$ gramme, stool I.	No gas.	Subcultures from this failed to grow.						
Nos. 20 to 25.—Isolated from $\frac{1}{1000000}$ gramme, stool I.	Acid and gas.	As all these microbes formed acid and gas in lac peptone cultures they were not studied further.						
Nos. 26 to 36.—Isolated from $\frac{1}{1000000}$ gramme, stool III.	Acid and gas.	As all these microbes formed acid and gas in lac peptone cultures they were not studied further.						
Nos. 37, 38.—Isolated from $\frac{1}{1000000}$ gramme, stool V.	Acid and gas.	As both these microbes formed acid and gas in lac peptone cultures they were not studied further.						
Nos. 39 to 50.—Isolated from $\frac{1}{1000000}$ gramme, stool VI.	Acid and gas.	As all these microbes formed acid and gas in lac peptone cultures they were not studied further.						
Nos. 51 to 62.—Isolated from $\frac{1}{1000000}$ gramme, stool VII.	Acid and gas.	As all these microbes formed acid and gas in lac peptone cultures they were not studied further.						

* For example, some liquefying chromogenic (yellow) coli-like micro isolated from oysters, waters, cress and other materials.

† These records may possibly serve as useful "controls" to those investigat who seek to associate certain human diseases with the presence in the intesti of the sufferers of specific non-lactose fermenting microbes.

TABLE I.—*continued.*

Description of the coli-like microbe.	Lactose peptone cultures (48 hours at 37° C.).	Proskauer and Capaldi's medium No. I. (24 hours at 37° C.).	Proskauer and Capaldi's medium No. II. (24 hours at 37° C.).	Neutral red broth cultures (48 hours at 37° C.).	Indol in broth cultures (5 days at 37° C.).	Litmus milk cultures (5 days at 37° C.).	Gelatine shake cultures (24 hours at 20° C.).	Glucose peptone cultures (48 hours at 37° C.).
No. 63* } Isolated from [illegible] gramme, stool VIII.	Acid, no gas.	Cherry red colour.	Acid change.	Fluorescence.	Negative	Acid, no clot.	Negative.	No gas.
No. 64*	Acid, no gas.	Cherry red colour	Acid change.	Fluorescence.	Negative	Acid, no clot.	Negative.	No gas.
No. 65*	Acid, no gas.	Cherry red colour.	Acid change.	Fluorescence.	Positive	Acid no clot.	Negative.	No gas.
No. 66*	Acid, no gas.	Cherry red colour.	[illegible] change.	Fluorescence	Negative	Acid and clot.	Negative.	No [illegible]
Nos. 67 to 142.—Isolated from [illegible] gramme, stool VIII.	Acid and gas.	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						
Nos. 143 to 159.—Isolated from [illegible] gramme, stool VIII.	Acid and gas.	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						
Nos. 160, 161, 162. Isolated from [illegible] gramme, stool VIII.	Acid and gas.	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						
Nos. 163 to 178.—Isolated from [illegible] gramme, stool IX.	Acid and gas.	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						
Nos. 179 to 198.—Isolated from [illegible] gramme, stool X.	Acid and gas.	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						
Nos. 199 to 218.—Isolated from [illegible] gramme, stool XIV.	Acid and gas.	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						
Nos. 219 to 238.—Isolated from [illegible] gramme, stool XV.	Acid and gas.	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						
Nos. 239 to 242.—Isolated from [illegible] gramme, stool XVII.	Acid and gas	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						
No. 243.—Isolated from [illegible] gramme, stool XVII.	Acid and gas.	As this microbe formed acid and gas in lactose peptone medium it was not studied further.						
Nos. 244 to 267	Acid and gas.	As all these microbes formed acid and gas in lactose peptone cultures they were not studied further.						

* 1 cc. of a 48 hours' broth culture (incubated at 37° C.) inoculated subcutaneously into a guinea-pig. The animal was only slightly affected and recovered from the effects of the injection

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B.—*The Cause of the Virulence of Broth Cultures Inoculated with Minute Amounts of Human Fæces, and Incubated at 37° C. for 48 hours.*

It has already been pointed out that in last year's work (1902–3) difficulty was experienced in accounting for the fact that broth cultures inoculated with minute amounts of human fæces proved highly virulent to rodents, whereas broth cultures of B. coli isolated from *parallel amounts* of the same material were commonly either non-pathogenic or, at all events, not virulent.

The following experiments were carried out with the object of throwing some light on this problem :—

Experiment I., Fæces I.—Broth cultures were severally inoculated with (*a*) $\frac{1}{1000}$, (*b*) $\frac{1}{10000}$, (*c*) $\frac{1}{100000}$, (*d*) $\frac{1}{1000000}$, (*e*) $\frac{1}{10000000}$, (*f*) $\frac{1}{100000000}$, (*g*) $\frac{1}{1000000000}$, and (*h*) $\frac{1}{10000000000}$ of a gramme of fæces. The cultures were incubated at 37° C. for two days. Growth occurred in all the tubes except cultures (*f*), (*g*), (*h*). Two guinea-pigs (d^1, e^1) were inoculated, the one with 1 cc. of (*d*) and the other with 1 cc. of (*e*) culture. Guinea-pig (e^1) was seemingly only slightly affected, but guinea-pig (d^1) died on the second day. From its heart's blood a microbe (microbe I.) was isolated in pure culture. Its biological attributes are set forth in Table II. 1 cc. of a 48 hours' broth culture of this microbe (microbe I.) was injected subcutaneously into a guinea-pig. The animal died, but not until the third day, so that it could not be said that microbe I. was highly virulent.

Experiment II., Fæces II.—In this experiment five guinea-pigs (a^1, b^1, c^1, d^1, e^1) were inoculated with 1 cc. of broth cultures representing (*a*) $\frac{1}{1000}$, (*b*) $\frac{1}{10000}$, (*c*) $\frac{1}{100000}$, (*d*) $\frac{1}{1000000}$, (*e*) $\frac{1}{10000000}$ respectively of a gramme of fæces. Guinea-pigs (a^1) and (b^1) both died within 24 hours. From the heart's blood of (a^1) guinea-pig a coli-like microbe (microbe II.) was isolated, and from the heart's blood of (b^1) guinea-pig another coli-like microbe (microbe III.) and as well a *query* streptococcus. The biological attributes of microbes II. and III. are shown in Table II. 1 cc. of a 48 hours' broth culture of microbe II. was injected subcutaneously into a guinea-pig. A localised swelling occurred, but the animal recovered. A precisely similar result was obtained as regards microbe III. Two mice were inoculated subcutaneously each with 1 cc. of a 48 hours broth culture of the *query* streptococcus micro-organism previously alluded to. The result was negative. Another guinea-pig was inoculated with a mixture of 0·5 cc. of the streptococcus broth culture and 0·5 cc. of the microbe III. broth culture. A localised swelling developed, but the animal recovered.

Experiment III., Fæces III.—In this experiment three guinea-pigs (e^1, f^1, g^1) were inoculated with 1 cc. of broth cultures representing (*e*) $\frac{1}{10000000}$, (*f*) $\frac{1}{100000000}$, and (*g*) $\frac{1}{1000000000}$ respectively of a gramme of fæces. Guinea-pig (e^1), but not guinea-pigs (f^1) and (g^1), died within two days. From the heart's blood of (e^1) guinea-pig a coli-like microbe (microbe IV.) was isolated (*see* Table II). 1 cc. of a broth culture (48 hours at 37° C.) of microbe IV. was injected subcutaneously into a guinea-pig. The animal died, but not until the third day.

Experiment IV., Fæces IV.—In this experiment the procedure was modified. Instead of broth cultures bile-salt glucose peptone cultures were used. This medium, although not specific for B. coli, does not, at all events, encourage the active growth of most species of microbes which do not belong to the coli group. Three guinea-pigs (b^1, c^1, d^1) were inoculated with 5 cc. of bile-salt glucose peptone cultures representing (*b*) $\frac{1}{10000}$, (*c*) $\frac{1}{100000}$, and (*d*) $\frac{1}{1000000}$ respectively of a gramme of fæces. The cultures proved very virulent. From the heart's blood of (d^1) guinea-pig a coli-like microbe (microbe V.) was isolated (*see* Table II.). 1 cc. of a broth culture (48 hours at 37° C.) of microbe V. was injected subcutaneously into a guinea-pig. The animal developed a big swelling, but eventually recovered.

Experiment V., Fæces V.—In this experiment three guinea-pigs (a^1, b^1, c^1) were inoculated subcutaneously with bile-salt glucose peptone cultures representing (*a*) $\frac{1}{1000}$, (*b*) $\frac{1}{10000}$, and (*c*) $\frac{1}{100000}$ respectively of a gramme of fæces. Guinea-pigs

(b'), and (c') had swollen bellies, and were decidedly ill within 24 hours. Guinea-pig (a') succumbed in less than 24 hours. From the hypereemic site of inoculation (guinea-pig a') a coli-like microbe (microbe VI.) was isolated (*see* Table II.). 1 cc. of a broth culture (48 hours at 37° C.) of microbe VI was injected subcutaneously into a guinea-pig. The animal suffered from a localised swelling and remained ill for several days, but it eventually recovered.

Experiment VI., Fæces VI.—In this experiment the effect was tried of inoculating guinea-pigs subcutaneously with filtered and unfiltered bile-salt glucose peptone cultures of fæces and with heated and unheated broth cultures of the same material.

A.—Bile-salt glucose peptone cultures (a, b, c, d, e, f, g, h) representing respectively $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$, $\frac{1}{1000000}$, $\frac{1}{10000000}$, $\frac{1}{100000000}$, $\frac{1}{1000000000}$, $\frac{1}{10000000000}$ gramme of fæces were mixed together in a sterile vessel. Part of the mixture was filtered through a sterile Pasteur filter.

Guinea-pig (a) was inoculated with 5 cc. of unfiltered mixture.
" (b) " " " filtered mixture.

Guinea-pig (a) seemed at first to be less affected than guinea-pig (b). Later, however, it grew worse. The abdominal wall ulcerated, but it eventually recovered. Guinea pig (b) was very ill during the first 24 hours, although there was little or no swelling at the site of inoculation, and was expected to die. Its condition gradually improved and recovery took place.

B.—A broth culture (d) representing one-millionth of a gramme of fæces was divided into two portions. One portion was heated to 65° C. for 15 minutes.

Guinea-pig (a) was inoculated with 2 cc. of unheated culture.
" (b) " " " heated culture.

Guinea-pig (a) seemed at first to be less affected than guinea pig (b). It got, however, progressively worse, a big swelling developed at the site of inoculation, and death occurred on the third day. Guinea-pig (b) had little or no swelling, but during the first 24 hours appeared to be more affected constitutionally than guinea-pig (a). Nevertheless it eventually recovered.

Experiment VII. Fæces VII.—A. Bile-salt glucose peptone cultures (a, b, c, d, e, f, g) representing respectively $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$, $\frac{1}{1000000}$, $\frac{1}{10000000}$, $\frac{1}{100000000}$, $\frac{1}{1000000000}$ gramme of fæces were mixed together in a sterile vessel. Part of the mixture was filtered through a sterile Pasteur filter.

Guinea-pig (a) was inoculated with 10 cc. of unfiltered mixture.
" (b) " " " filtered mixture.

Guinea-pig (a) developed an enormous swelling, and ulceration of the abdominal wall occurred. On the fourth day, however, it was alive and appeared to be recovering from the effects of the injection. Guinea-pig (b) was much less affected, had little or no local swelling, and was lively and well on the fourth day.

B. Broth cultures (a, b, c, d, e, f) representing $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$, $\frac{1}{1000000}$, $\frac{1}{10000000}$, and $\frac{1}{100000000}$ of a gramme of fæces were mixed together in a sterile vessel. Part of the mixture was heated to 65° C. for 15 minutes.

Guinea-pig (a) was inoculated with 5 cc. of unheated culture.
" (b) " " " heated culture.

Guinea-pig (a) developed a big swelling and died on the third day.

Guinea pig (b) appeared to be but slightly affected and was alive and well on the fourth day.

Experiment VIII., Fæces VIII.—A. Bile-salt glucose peptone cultures (a, b, c, d, e) representing respectively $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$, $\frac{1}{1000000}$, and $\frac{1}{10000000}$ of a gramme of fæces were mixed together in a sterile vessel. Part of the mixture was filtered through a sterile Pasteur filter.

Guinea pig (a) was inoculated with 5 cc. of unfiltered mixture.
" (b) " " 10 cc. of filtered mixture.

Guinea-pig (*a*) was moribund within 24 hours. It was killed and a coli-like microbe (microbe VII.) was isolated from the site of the inoculation (*see* Table II.) 1 cc. of a broth culture (48 hours at 37° C.) of microbe VII. was injected subcutaneously into a guinea-pig. The animal remained ill for some days, but eventually recovered.

As regards guinea-pig (*b*), the injection of 10 cc. of the filtered mixture proved fatal within 24 hours.

B. Broth cultures (*a*, *b*, *c*, *d*, *e*) representing respectively $\frac{1}{100}$, $\frac{1}{1000}$, $\frac{1}{10000}$, $\frac{1}{100000}$ and $\frac{1}{1000000}$ of a gramme of fæces were mixed together in a sterile vessel. Part of the mixture was heated to 65° C. for 15 minutes.

Guinea-pig (1) was inoculated with 5 cc. of unheated culture.

" (2) " " 10 cc. of heated culture.

Guinea-pig (1) died within 24 hours and a coli-like microbe (microbe VIII.) was isolated from its spleen (*see* Table II.). 1 cc. of a broth culture (48 hours at 37° C.) of microbe VIII was inoculated subcutaneously into a guinea-pig. The animal died on the second day.

As regards guinea-pig (2), as it was found to be moribund on the day following the injection it was killed.

Speaking in the first instance of the experiments in which the primary broth cultures made from the fæces proved virulent to guinea-pigs, it is to be noted that usually B. coli or coli-like microbes were isolated from the dead rodent, but that secondary broth cultures of these microbes were not as pathogenic as perhaps might have been anticipated. Thus in Experiment I. microbe I. did indeed kill the animal, but not until the third day. In Experiment II. microbes II. and III. induced only a localised swelling. In Experiment III. the result was the same as in Experiment I. In Experiment VIII. (B), however, microbe VIII. killed the rodent within two days.

Somewhat similar results were obtained as regards the bile-salt glucose peptone cultures. Thus in Experiment IV. microbe V. produced a big swelling but did not kill the inoculated rodent. Similar results were obtained in the case of microbe VI., Experiment V., and as regards microbe VII., Experiment VIII. Nevertheless the fact that the bile-salt glucose peptone cultures were not uncommonly virulent favours the supposition that the cause of the virulence was due to B. coli or coli-like microbes since this medium does not inhibit the growth of this group of bacteria but retards or prevents the active multiplication of most other micro-organisms.

Next as regards the filtered as compared with the "unfiltered" bile-salt glucose peptone cultures, and the heated as contrasted with the "unheated" broth cultures. Seemingly both the filtered and heated cultures may on occasion prove pathogenic if not virulent to rodents. But while the products of the bacteria may conduce to the observed virulent effect of cultures in which fæcal microbes have been grown, the results seem to indicate that the presence of living microbes are essential to ensure the full virulence of such cultures.

Speaking of the experiments as a whole, the results appear to show that the products of the growth of the bacteria may assist

in producing the virulent effect observed in rodents consequent on injection of cultures previously sown with minute amounts of fæces, but that the presence of a *mixture* of *living* microbes, *probably belonging to the coli group*, is necessary to ensure the full virulence of such cultures.

TABLE II.

Showing the results of subculture of microbes isolated from rodents which had died as the result of injection of cultures previously inoculated with human fæces and incubated at 37° C. for two days.

Description of the microbe.	Lactose peptone cultures (48 hours at 37° C.).	Proskauer and Capaldi's medium No. I. (24 hours at 37° C.).	Proskauer and Capaldi's medium No. II. (24 hours at 37° C.).	Neutral red broth cultures (48 hours at 37° C.).	Indol in broth cultures (5 days at 37° C.).	Litmus milk cultures (5 days at 37° C.).	Gelatine "shake" cultures (24 hours at 20° C.).	Glucose peptone cultures (48 hours at 37° C.).
No. I.—Isolated from heart's blood of guinea-pig (c^1); experiment I., fæces I.	Acid and gas.	Cherry red colour.	Acid change.	Greenish yellow fluorescence.	No indol.	Acid, no clot.	No gas.	Acid, no gas.
No. II.—Isolated from heart's blood of guinea-pig (a^1); experiment II., fæces II.	Acid and gas.	Cherry red colour	Bleached appearance, ? acid.	Greenish yellow fluorescence.	+	Acid and clot.	+	Acid and gas.
No. III.—Isolated from heart's blood of guinea-pig (b^1); experiment II., fæces II.	Acid and gas.	Cherry red colour.	[illegible] appearance, ? acid.	Greenish yellow fluorescence.	+	Acid and clot.	+	Acid and gas.
No. IV. Isolated from heart's blood of guinea-pig (e^1); experiment III., fæces III.	Acid, no gas.	Acid, but not distinct cherry red colour.	Slight acid change.	Greenish yellow fluorescence.	No indol.	Acid and clot.	+	Acid and gas.
No. V.—Isolated from heart's blood of guinea-pig (d^1); experiment IV., fæces IV.	Acid and gas.	Delayed production of cherry red colour.	Slight acid change.	Greenish yellow fluorescence.	+	Acid and clot.	+	Acid and gas.
No. VI.—Isolated from site of inoculation, guinea-pig (a^2); experiment V., fæces V.	Acid and gas.	Cherry red colour.	Slight acid change.	Greenish yellow fluorescence.	+	Acid and clot.	+	Acid and gas.
No. VII.—Isolated from site of inoculation, guinea-pig (a); experiment VIII., fæces VIII.	Acid and gas.	Cherry red colour.	? Acid change.	Ditto.	+	Acid and clot.	+	Acid [illegible] gas.
No. VIII.—Isolated from spleen of guinea-pig (f); experiment VIII., fæces VIII.	Acid and gas.	Cherry red colour.	? Acid change.	Ditto.	+	Acid and clot.	+	Acid and gas.

C. *Further Experiments as regards the Indol Test.*

By the indol test is meant ascertaining the smallest amoun a material which when sown in broth cultures and incubated 37° C. for five days is capable of producing indol.

Last year (1902–3) it was pointed out that in human fæces indol, bile-salt glucose peptone, neutral red broth, and lact peptone milk tests gave results broadly parallel with each oth and parallel also with the number of B. coli present.

This year (1903–4) some further records as regards the in test may be given.

Stool	I.	1 million, not 10 million	indol produci bacteria pe gramme o fæces.
„	II.	10 thousand, not 100 thousand	
„	III.	1,000 million, not 10,000 million	
„	IV.	1 million, not 10 million	
„	V.	10 thousand, not 100 thousand	
„	VI.	10,000 million	
„	VII.	100 million, not 1,000 million	
„	VIII.	10 million, not 100 million	

The results, as in last year's work (1902-3), were very variab but usually the number of indol-producing bacteria was ve great. This, of course, is due to the enormous number of typi B. coli in human fæces.

D. *The Numerical Abundance and Biological Attributes of Streptococci in Normal Stools* *

Nineteen stools were examined and over 300 streptococci we made the subject of special study.

The streptococci were examined in three series of 100 in ea series.

In the first series (streptococci 1–100) I used, at Dr. Gordo suggestion in regard of the sugar media, in the first instar a sugar free broth prepared as follows:—Ordinary broth w inoculated with B. coli and incubated for several days so as allow B. coli time to split up any sugars present in the bro The broth was next heated to kill B. coli, was "cleared" with wh of egg, and finally 1 per cent. of either inulin, salicin, saccharo lactose, raffinose, or mannite was added. After tinting w litmus solution it was filtered and poured into tubes a sterilised.

In the second and third series (streptococci 1A to 100A a 1B to 100B) I used a simpler medium, which seemed to answ equally well for the purposes of my investigation.

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* The correlation of the numerical abundance and biological attributes intestinal microbes is of great importance from the point of view of pu health bacteriology.

Its composition was as follows :—

Liebig's Extract of Meat ...	1	per cent.
Peptone	1	,,
Sodium carbonate	0·1	,,
× sugar	0·5	,,
Water	97·4	,,

(Tinted with litmus solution.)

SERIES I.

Streptococci 1 to 100.

Relative abundance.—The proportionate number of streptococci may be classified as follows :—

$\frac{1}{1000000}$ *of a gramme of fæces.*—1 to 13 (stool I.); 37 to 40 (stool III.); 41 to 47 (stool IV.); 48 to 69 (stool V.); 70, 71, 72 (stool VI.); 96 to 100 (stool VIII.).

$\frac{1}{10000000}$ *of a gramme of fæces.*—29 to 36 (stool III.); 73 to 79 (stool VI.); 82 to 95 (stool VII.).

$\frac{1}{100000000}$ *of a gramme of fæces.*—80, 81 (stool VI.).

$\frac{1}{1000000000}$ *of a gramme of fæces.*—14 to 28 (stool II.).

Broth cultures.—The results may be classified as follows :—

Diffuse cloudiness.—8, 12 to 28, 30, 31, 33 to 40, 43, 44, 46, 49 to 63, 65 to 79, 81 to 95, 97 to 100.

Diffuse cloudiness with flaky deposit at foot of tube.—10, 11.

Diffuse cloudiness with viscous deposit at foot of tube.—9.

Slight diffuse cloudiness with fluffy deposit at foot of tube.—6.

Nearly clear broth with granular deposit at foot of tube.—29, 48.

Clear broth with woolly masses at foot of tube.—32.

Clear broth with flocculent masses at foot of tube.—41, 45, 47.

Clear broth with cumulus growth at foot of tube.—42.

Mixture of diffuse and granular cloudiness.—7, 64.

Slight diffuse cloudiness with granular deposit at foot of tube.—96.

Clear broth with flaky masses at foot of tube.—80.

Slight cloudiness with cirrhus streaks on side of tube.—1 to 5.

It is to be noted that 80 per cent. of the streptococci produced diffuse cloudiness in broth cultures.

Of the 100 streptococci, 54, 29, 2, and 15 per cent. were isolated respectively from $\frac{1}{100000}$, $\frac{1}{1000000}$, $\frac{1}{10000000}$, and $\frac{1}{1000000000}$ of a gramme of fæces.

Morphology.—Although morphology is apt to be an uncerta aid to differentiation of species, some rough classification must b attempted.

Short to medium chains, but on the whole short chains.—7, 12 to 31, 33 to 40, 43, 44, 46, 49 to 54, 56 to 78, 81 to 9 97 to 100.

Short, somewhat coherent chains.—1 to 5, 10, 11, 48, 55, 79,9

Medium, somewhat coherent chains.—6, 80.

Medium chains.—9, 32.

Medium to long chains.—41, 45, 47.

Long chains.—42.

It will be noted that about 81 per cent. of the streptococci con under the category of short chains without coherence.

*Gelatine "streak" cultures (at 20° C.).**—No more than broad statement is permissible under this heading.

Minute transparent streptococcus-like colonies.—1 to 8, 10, 1 14 to 28, 32, 35, 36, 39, 41, 42, 43, 45 to 48, 50, 52, 54 57, 60, 61, 64, 65, 67, 68, 69, 96, 97.

Less minute, more opaque, but still streptococcus like colonie —12, 13, 49, 51, 53, 58, 59, 62, 63, 66, 71, 73, 75, 78, 8 to 95.

Extremely feeble growth.—9, 76, 79, 80.

Either no visible growth or practically no growth with 10 days at 20° C.—29, 30, 31, 33, 34, 37, 38, 40, 44, 70, 7 74, 77, 81, 98, 99, 100.

Pathogenesis.—In last year's work (1902-3) it was found th practically all the streptococci were non-virulent in mice. This ye (1903-4) the effect was tried of mixing together in a sterile vess broth cultures (2 days at 37° C.) of a number of streptococci an inoculating mice with 1 cc. of the mixture. The results may b tabulated as follows :—

Mixture of broth cultures of streptococci.	1 cc. of mixture injected subcutaneously into —	Animals kept under observation for 10 days, with the following result
1 to 13	Two mice	Negative result.
14 to 28	Two mice	Negative result.
29 to 40	Two mice	Negative result.
41 to 47	Two mice	Negative result.
48 to 69	Two mice	Negative result.
70 to 81	Two mice	Negative result.
82 to 95	Two mice	Negative result.
96 to 100	Two mice	Negative result.

* None of the streptococci liquefied gelatine.

It will be seen from the foregoing that the results were wholly negative. This does not mean that the streptococci (separately or in conjunction) would be necessarily non-pathogenic to all other animals under every conceivable set of conditions. Still less does it follow that the streptococci derived from the fæces of diseased persons are of necessity harmless to men and the lower animals.

As regards the remaining eight tests, viz., salicin, saccharose, lactose, raffinose, litmus milk, neutral red (anaërobic), inulin, and mannite, the results have been grouped together in a table (Table III.).

TABLE III.

Showing the biological attributes of 100 streptococci isolated from normal human fæces.

[Series I. Streptococci 1 to 100.]

Streptococcus.		Salicin. + = acid change (2 days at 37° C.).	Saccharose. + = acid change (2 days at 37° C.).	Lactose. + = acid change (2 days at 37° C.).	Raffinose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.).	Neutral Red (Anaërobic). + = fluorescence (2 days at 37° C.).	Inulin. + = acid change (2 days at 37° C.).	Mannite. + = acid change (2 days at 37° C.).
1/100000 gramme, stool I.	1	+	+	o	+	o	o	o	o
	2	+	+	o	o	o	o	o	o
	3	+	+	o	+	o	o	o	o
	4	+	+	o	+	o	o	+	o
	5	+	o	o	+	o	o	o	o
	6	+	o	o	+	o	o	o	o
	7	+	+	o	+	o	o	o	o
	8	+	o	+	o	+	o	o	o
	9	+	+	o	+	o	o	+	+
	10	+	+	o	+	o	o	o	o
	11	+	o	o	+	o	o	o	o
	12	+	+	+	o	+	o	o	o
	13	+	+	+	o	+	+	o	+

TABLE III.—*continued.*

Appendix B, No. 7.

Report on Bacteriological Examination of (1) Excreta of Man, (2) Excreta of Sea-fowl and Fish; and (3) certain Potable Waters; by Dr. Houston.

	Streptococcus.	Salicin. + = acid change (3 days at 37° C.).	Saccharose. + = acid change (3 days at 37° C.).	Lactose. + = acid change (2 days at 37° C.)	Raffinose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.).	Neutral Red (Anaerobic). + = fluorescence (2 days at 37° C.).	Inulin. + = acid change (2 days at 37° C.).	Mannite. + = acid change (3 days at 37° C.).
1/1000000000 gramme stool II.	14	+	+	+	+	+	o	o	o
	16	+	+	+	+	+	o	o	o
	18	+	+	+	+	+	o	o	o
	17	+	+	+	+	+	o	o	o
	19	+	+	+	+	+	o	o	o
	20	+	+	+	+	+	o	o	o
	21	+	+	+	+	+	o	o	o
	15	+	+	+	+	+	o	o	o
	23	+	+	+	+	+	o	o	o
	24	+	+	+	+	+	o	o	o
	25	+	+	+	+	+	o	o	o
	27	+	+	+	+	+	o	o	o
	26	+	+	+	+	+	o	o	o
	36	+	+	+	+	+	o	o	o
1/1000000 gramme stool III.	29	+	+	+	+	+	o	o	o
	30	+	+	+	+	+	o	o	o
	31	+	+	+	+	+	o	o	o
	32	+	+	+	+	+	o	o	o
	33	+	+	+	+	+	o	o	o
	34	+	+	+	+	+	o	o	o
	35	+	+	+	+	+	o	o	o
	38	+	+	+	+	+	o	o	o
1/100000 gramme, stool III.	37	+	+	+	+	+	o	o	o
	39	+	+	+	+	+	o	o	o
	40	+	+	+	+	+	o	o	o
1/100000 gramme, stool IV.	41	o	+	+	o	+	o	o	o
	42	o	+	+	o	+	o	o	o
	43	+	+	+	+	+	o	o	o
	44	+	+	+	+	+	o	o	o
	45	o	+	+	o	+	o	o	o
	46	o	+	+	o	+	o	o	o
	47	+	+	+	+	+	o	o	o

TABLE III.—*continued.*

1/10000000 gramme, stool VI.		1/1000000 gramme, stool VI.							1/100000 gramme, stool VI.			1/100000 gramme, stool V.																				Streptococcus.	
20	20	24	23	23	22	22	21	21	21	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	19		
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Salicin. + = acid change (3 days at 37° C.).	
+	+	+	+	+	+	+	o	+	+	+	+	+	+	+	+	+	o	o	+	+	o	o	+	+	+	+	o	+	+	+	o	+	Saccharose. + = acid change (3 days at 37° C.).
+	o	o	+	+	+	+	+	+	+	+	+	o	o	o	+	+	+	+	+	o	o	+	+	o	o	+	+	+	+	o	+	o	+	Lactose. + = acid change (2 days at 37° C.).
o	o	+	o	o	o	o	o	o	o	o	o	+	+	+	o	+	+	o	o	+	+	o	o	+	+	+	+	o	+	o	+	+	+	Raffinose. + = acid change (2 days at 37° C.).
+	o	o	+	+	+	+	+	+	+	+	+	o	o	o	+	+	+	o	o	+	+	o	o	+	+	+	+	o	o	o	+	+	+	Litmus Milk. + = acid and clot (5 days at 37° C.).
o	o	+	+	o	+	o	o	o	o	+	o	o	o	o	+	+	o	+	+	o	o	+	+	o	o	o	o	+	o	+	o	+	o	Neutral Red (Anaerobic). + = fluorescence (2 days at 37° C.).
o	o	+	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	+	o	+	o	o	o	Inulin. + = acid change (2 days at 37° C.).
o	o	o	+	o	o	o	o	o	o	+	o	o	o	o	+	o	o	o	o	o	o	o	o	o	o	o	o	+	o	o	+	o	o	o	Mannite. + = acid change (2 days at 37° C.).

Report on Bacteriological Examination of (1) Excreta of Man; (2) Excreta of Fee-fowl and Fish; and (3) certain Potable Waters; by Dr Houston

TABLE III.—*continued.*

Streptococcus.		Salicin + = acid change (2 days at 37° C.).	Saccharose. + = acid change (2 days at 37° C.).	Lactose, + = acid change (2 days at 37° C.).	Raffinose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.).	Neutral Red (Anaërobic). + = fluorescence (2 days at 37° C.).	Inulin. + = acid change (2 days at 37° C.).	Mannite. + = acid change (2 days at 37° C.).
1/1000000 gramme, stool VII.	82	+	+	+	+	o	+	o	o
	83	+	+	+	+	o	+	o	o
	84	+	+	+	+	o	+	o	o
	85	+	+	+	+	o	+	o	o
	86	+	+	+	+	o	+	o	o
	87	+	+	+	+	o	+	o	o
	88	+	+	+	+	o	+	o	o
	89	+	+	+	+	o	+	o	o
	90	+	+	+	+	o	+	o	o
	91	+	+	+	+	o	+	o	o
	92	+	+	+	+	o	+	o	o
	93	+	+	+	+	o	+	o	o
	94	+	+	+	+	o	+	o	o
	95	+	+	+	+	o	+	o	o
1/1000000 gramme, stool VIII.	96	+	+	+	o	o	o	o	o
	97	+	+	o	+	o	o	o	o
	98	+	+	+	o	+	+	o	o
	99	+	+	+	o	+	o	o	o
	100	+	+	+	o	+	o	o	o
		96% +	89% +	66% +	62% +	51% +	35% +	12% +	7% +

The results shown in Table III. may be classified as follows :—

Salicin medium.—96 per cent. of the streptococci yielded positive results, that is reddening* of the litmus. Their numbers are as follows :—1 to 40, 43, 44, 47 to 100.

Saccharose medium.—89 per cent. of the streptococci yielded positive results, namely, as follows :—1 to 4, 7, 9, 10, 12 to 48, 50, 51, 52, 54 to 57, 60, 61, 64 to 72, 74 to 100.

Lactose medium.—66 per cent. of the streptococci yielded positive results, namely, as follows :—8, 12 to 29, 31, 33, 37, 40, 41, 46, 48, 49, 51, 53, 54, 55, 58, 59, 62 to 66, 70 to 78, 81 to 96, 98, 99, 100.

* With some of the tests, and in a few instances, the medium was bleached rather than rendered red. These have been classed as positive.

Raffinose medium.—62 per cent. of the streptococci yielded positive results, namely, as follows :—1, 3 to 7, 9, 10, 11, 14 to 28, 34 to 39, 42, 48, 49, 50, 52, 54 to 57, 60, 61, 64, 65, 67, 68, 69, 79, 82 to 95, 97.

Litmus milk cultures.—51 per cent. of the streptococci produced acid and clotting of the medium, namely, as follows :—8, 12 to 29, 31, 33, 37, 40, 41, 45 to 49, 53, 54, 55, 58, 59, 62 to 65, 70 to 78, 81, 98, 99, 100.

Neutral red broth cultures (anaërobic).*—35 per cent. of the streptococci produced greenish yellow fluorescence in this medium, namely, as follows :—13, 29, 33, 35, 37, 38, 46, 49, 51, 53, 58, 59, 62, 63, 65, 66, 71, 76, 78, 79, 82 to 95, 98.

Inulin medium.—12 per cent. of the streptococci yielded positive results, namely, as follows :—4, 9, 29, 34, 35, 36, 38, 39, 43, 52, 54, 79.

Mannite medium.—7 per cent. of the streptococci yielded positive results, namely, as follows :—9, 13, 51, 54, 66, 71, 78.

The foregoing results may be briefly summarised as follows :—

Salicin ...	...	...	96	per cent.	positive.
Saccharose	...	...	89	„	„
Lactose...	...	...	66	„	„
Raffinose	...	...	62	„	„
Litmus milk	...	...	51	„	„
Neutral red	...	...	35	„	„
Inulin ...	...	...	12	„	„
Mannite	...	...	7	„	„

A further analysis of the foregoing table (Table III.) shows that the streptococci may be divided into 25 groups, as under :—

Salicin, *saccharose*, *lactose*, *raffinose*, *litmus milk* positive, other tests negative, 18 per cent, namely, as follows :—14 to 28, 48, 55, 64.

Salicin, *saccharose*, *lactose*, *raffinose*, *neutral red* positive other tests negative, 14 per cent., namely, as follows :—82 to 95.

Salicin, *saccharose*, *raffinose* positive, other tests negative, 13 per cent., namely, as follows :—1, 3, 7, 10, 50, 56, 57, 60, 61, 67, 68, 69, 97.

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* Unfortunately, between a fæcal steptococcus which gives a completely positive result and one which produces no change in this medium there is every conceivable gradation. So that it becomes a matter of great difficulty to know where to draw the line. Speaking solely of fæcal streptococci, the personal equation dominates largely the question of the percentage number of positive and negative results obtained by the use of this test.

Salicin, saccharose, lactose, litmus milk positive, other tests negative, 11 per cent., namely, as follows:—12, 31, 47, 70, 72, 74, 75, 77, 81, 99, 100.

Salicin, lactose, litmus milk, neutral red positive, other tests negative, 5 per cent., namely, as follows:—53, 58, 59, 62, 63.

Salicin, saccharose, raffinose, inulin positive, other tests negative, 5 per cent., namely, as follows:—4, 34, 36, 39, 52.

Salicin, saccharose positive, other tests negative, 5 per cent. namely, as follows:—2, 30, 32, 44, 80.

Salicin, saccharose, lactose, litmus milk, neutral red, mannite positive, other tests negative, 3 per cent., namely, as follows:—13, 71, 78.

Salicin, saccharose, lactose, litmus milk, neutral red positive, other tests negative, 3 per cent., namely, as follows:—33, 76, 98.

Salicin, saccharose, raffinose, neutral red, inulin positive, other tests negative, 3 per cent., namely, as follows:—35, 38, 79.

Salicin, raffinose positive, other tests negative, 3 per cent. namely, as follows:—5, 6, 11.

Salicin, saccharose, lactose, raffinose, litmus milk, neutral red positive, other tests negative, 2 per cent., namely, as follows:—37, 65.

Salicin, saccharose, lactose, neutral red, mannite positive, other tests negative, 2 per cent., namely, as follows:—51, 66.

Salicin, lactose, litmus milk positive, other tests negative, 2 per cent., namely, as follows:—8, 73.

Salicin, saccharose, lactose, raffinose, litmus milk, inulin, mannite positive, other tests negative, 1 per cent., namely, as follows:—54.

Salicin, saccharose, lactose, litmus milk, neutral red, inulin positive, other tests negative, 1 per cent., namely, as follows:—29.

Salicin, saccharose, raffinose, inulin, mannite positive, other tests negative, 1 per cent., namely, as follows:—9.

Salicin, lactose, raffinose, litmus milk, neutral red positive, other tests negative, 1 per cent., namely, as follows:—49.

Saccharose, lactose, litmus milk, neutral red positive, other tests negative, 1 per cent., namely, as follows:—46.

Saccharose, lactose, litmus milk positive, other tests negative, 1 per cent., namely, as follows:—41.

Saccharose, salicin, inulin positive, other tests negative, 1 per cent., namely, as follows :—43.

Salicin, saccharose, litmus milk positive, other tests negative, 1 per cent., namely, as follows :—47.

Salicin, saccharose, lactose positive, other tests negative, 1 per cent., namely, as follows :—96.

Saccharose, raffinose, positive, other tests negative, 1 per cent., namely, as follows :—42.

Saccharose, litmus milk positive, other tests negative, 1 per cent., namely, as follows :—45.

SERIES II.

Streptococci 1A to 100A.

Relative abundance.—The streptococci may be classified as regards their number in the following manner :—

$\frac{1}{1000000}$ *of a gramme of faces* :—3A to 30A (stool IX.).

31A to 66A (stool X.).

67A to 93A (stool XI.).

94A to 100A (stool XII.).

$\frac{1}{10000000}$ *of a gramme of fæces* :—1A and 2A (stool IX.).

Of the 100 streptococci 98 per cent. were isolated from $\frac{1}{10000000}$ of a gramme of fæces.

Broth cultures.—The results may be classified as follows :—

Diffuse cloudiness.—1A to 36A, 39A, 46A, 47A, 49A, 52A, 53A, 55A, 57A, 59A, 60A to 65A, 67A to 87A.

Clear broth with granular masses at foot of tube.—40A to 43A, 88A to 94A.

Mixture of diffuse and flaky cloudiness.—4 A, 48A, 50A, 51A, 54A, 56A, 58A, 66A.

Clear broth with cirrhus streaks on side of tube.—95A, to 99A.

Granular cloudiness.—37A.

Mixture of diffuse and granular cloudiness.—38A.

Clear broth, scanty growth at foot of tube.—44A.

Slight cloudiness, coherent mass at foot of tube—100A.

It will be noted that 72 per cent. of the streptococci uniform turbidity in broth culture.

Morphology.—The following is a rough classification unde foregoing heading:—

Short to medium chains, but on the whole short chains to 36A, 39A, 46A, 47A, 49A, 52A, 53A, **55A**, 57A, 59A, to 64A, 67A to 87A.

Short to medium chains, but many chains of medium leng 44A, 45A, 48A, 50A, 51A, 54A, 56A, 58A, 60A, 65A, 66

Short, somewhat coherent chains.—37A, 38A, 40A to 43A, 93A.

Medium, somewhat coherent chains.—88A to 91A, 94A, 10

Medium to long chains.—95A to 99A.

It will be noted that about 70 per cent. of the streptococci c under the category of short chains without coherence.

*Gelatine "streak" cultures.**—

Minute transparent streptococcus-like colonies.—1A to 37A to 43A, 45A, 47A, 51A, 52A, 54A, 56A, 58A, 60A, 66A, 92A, 93A, 94A, 100A.

Less minute, more opaque, but still streptococcus-like colo —31A to 36A, 46A, 49A, 53A, 55A, 57A, 59A, 61A to 67A to 87A.

Extremely feeble growth.—48A.

Either no visible growth, or practically no growth, with days at 20° C.—44A, 50A, 88A to 91A, 95A to 99A.

Nitrate broth test (2 days at 37° C.)†—In this series (Series and in the next and last series (Series III.) no experim as regards pathogenicity were made. But instead, all the stre cocci were tested as regards their ability to reduce nitrate nitrites. The reduction of nitrates to nitrites is a conspic property of the coli group of bacteria.‡ *Not one of the streptococci that were tested were capable of reducing nitrat nitrites.*

As regards the remaining eight tests viz., salicin, saccha lactose, raffinose, litmus milk, neutral red (anaërobic), inulin, mannite, the results have been grouped together in a t (Table IV.).

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* None of the streptococci liquefied gelatine.

† KNO_3, 0·1 per cent. ordinary broth, 1·0 per cent.; water, 99·0 per cent.

‡ In last year's work (1902-3) 1·61 per cent. of the coli reduced nitra nitrites.

TABLE IV.

Showing the biological attributes of 100 streptococci isolated from normal human fæces.

[Series II. Streptococci 1A to 100A.]

Streptococci.		Salicin. + = acid change (2 days at 37° C.).	Saccharose. + = acid change (2 days at 37° C.).	Lactose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.).	Neutral Red (Anaërobic). + = fluorescence (2 days at 37° C.).	Mannite. + = acid change (2 days at 37° C.).	Raffinose. + = acid change (2 days at 37° C.).	Inulin. + = acid change (2 days at 37° C.).
1/10000000 gramme, stool IX.	1A	+	+	+	+	o	o	o	o
	2A	+	+	+	+	o	o	o	o
1/10000000 gramme, stool IX.	3A	+	+	+	+	o	o	o	o
	4A	+	+	+	+	o	o	o	o
	5A	+	+	+	+	o	o	+	o
	6A	+	+	+	o	o	o	o	o
	7A	+	+	+	o	o	o	o	o
	8A	+	+	+	o	o	o	o	o
	9A	+	+	+	o	+	o	o	o
	10A	+	+	+	o	o	o	o	o
	11A	+	+	+	o	o	o	o	o
	12A	+	+	+	o	o	o	o	o
	13A	+	+	+	o	o	o	o	o
	14A	+	+	+	o	o	o	o	o
	15A	+	+	+	o	o	o	o	o
	16A	+	+	+	o	o	o	o	o
	17A	+	+	+	o	o	o	o	o
	18A	+	+	+	o	o	o	o	o
	19A	+	+	+	o	o	o	o	●
	20A	+	+	+	o	o	o	o	o
	21A	+	+	+	o	o	o	o	o
	22A	+	+	+	o	o	o	o	o
	23A	+	+	+	o	o	o	o	o
	24A	+	+	+	o	o	o	o	o
	25A	+	+	+	o	o	o	o	o
	26A	+	+	+	o	o	o	o	o
	27A	+	+	+	o	o	o	o	o
	28A	+	+	+	o	+	o	+	o
	29A	+	+	+	o	+	o	+	o
	30A	+	+	+	o	o	o	o	o

App. B, No. 7.

Report on Bacteriological Examination of (1) Excreta of Man, (2) Excreta of Sea-fowl and Fish; and (3) certain Potable Waters; by Dr. Houston.

Table IV.—*continued.*

Streptococci.		Salicin. + = acid change (2 days at 37° C.).	Saccharose. + = acid change (2 days at 37° C.).	Lactose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.).	Neutral Red (Anaërobic). + = fluorescence (2 days at 37° C.).	Mannite. + = acid change (2 days at 37° C.).	Raffinose. + = acid change (2 days at 37° C.).
1/1000000 gramme, stool X.	31A	+	o	+	+	+	+	o
	32A	+	+	+	+	+	+	o
	33A	+	o	+	+	+	+	o
	34A	+	o	+	+	+	+	o
	35A	+	o	+	+	+	+	o
	36A	+	o	+	+	o	o	o
	37A	+	+	+	+	+	o	[illegible]
	38A	+	+	o	o	o	o	o
	39A	+	+	o	o	+	o	o
	40A	+	+	o	o	+	o	o
	41A	+	+	+	+	+	o	o
	42A	+	+	o	o	o	o	o
	43A	+	+	o	o	+	o	o
	44A	o	o	o	o	o	o	o
	45A	+	+	o	o	o	o	o
	46A	+	o	+	+	o	o	o
	47A	+	+	o	o	o	o	o
	48A	+	+	o	o	o	o	o
	49A	+	o	+	+	o	o	o
	50A	+	+	o	o	+	o	+
	51A	+	+	o	o	o	o	o
	52A	+	+	o	o	o	o	o
	53A	+	o	+	+	o	o	o
	54A	+	+	o	o	o	o	o
	55A	+	o	+	+	o	o	o
	56A	+	+	o	o	o	o	o
	57A	+	o	+	+	o	o	o
	58A	+	+	o	o	o	o	o
	59A	+	o	+	+	o	o	o
	60A	+	+	o	o	o	o	o
	61A	+	o	+	+	+	o	o
	62A	+	o	+	+	o	o	o
	63A	+	o	+	+	o	o	o
	64A	+	o	+	+	o	o	o
	65A	+	+	o	o	o	o	o
	66A	+	+	o	o	o	o	o

TABLE IV.—*continued.*

Streptococci.		Salicin. + = acid change (2 days at 37° C.).	Saccharose. + = acid change (2 days at 37° C.).	Lactose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.).	Neutral Red (Anaërobic). + = fluorescence (2 days at 37° C.).	Mannite. + = acid change (2 days at 37° C.).	Raffinose. + = acid change (2 days at 37° C.).	Inulin. + = acid change (2 days at 37° C.).
1/100000 gramme, stool XI.	67A	+	+	+	+	o	+	o	o
	68A	+	+	+	+	o	+	o	o
	69A	+	+	+	+	o	+	o	o
	70A	+	+	+	+	o	+	o	o
	71A	+	+	+	+	+	+	o	o
	72A	+	+	+	+	o	+	o	o
	73A	+	+	+	o	o	+	+	o
	74A	+	+	+	+	o	+	o	o
	75A	+	+	+	+	+	+	o	o
	76A	+	+	+	+	+	+	o	o
	77A	+	+	+	+	+	+	+	o
	78A	+	+	+	+	+	+	o	o
	79A	+	+	+	+	+	+	o	o
	80A	+	+	+	+	+	o	+	o
	81A	+	+	+	+	+	+	o	o
	82A	+	+	+	+	+	+	o	o
	83A	+	+	+	+	+	+	o	o
	84A	+	+	+	+	+	+	o	o
	85A	+	+	+	+	+	+	o	o
	86A	+	+	+	+	+	+	o	o
	87A	+	+	+	+	+	+	o	o
	88A	o	+	o	+	o	o	o	o
	89A	+	+	o	o	+	o	o	o
	90A	+	+	+	+	+	o	o	o
	91A	+	+	+	+	+	+	o	o
	92A	o	+	o	+	o	o	o	o
	93A	o	+	o	+	o	o	o	o
1/100000 gramme, stool XII.	94A	o	+	+	+	o	o	o	o
	95A	o	+	+	+	o	o	o	o
	96A	o	+	+	+	o	o	o	o
	97A	+	+	+	+	+	+	o	o
	98A	o	+	+	+	o	o	o	o
	99A	o	+	+	+	+	o	o	o
	100A	+	+	+	+	+	o	+	o
		91 % +	84 % +	78 % +	65 % +	85 % +	27 % +	8 % +	None +

The results shown in Table IV. may be classified as follo

Salicin medium.—91 per cent. of the streptococci y positive results, namely, as follows:—1A to 43A, 87A, 89A to 91A, 97A, 100A.

Saccharose medium.—84 per cent. of the streptococci y positive results, namely, as follows:—1A to 30A 37A to 43A, 45A, 47A, 48A, 50A to 52A, 54A, 56A 60A, 65A to 100A.

Lactose medium.—78 per cent. of the streptococci y positive results, namely, as follows:—1A to 37A 46A, 49A, 53A, 55A, 57A, 59A, 61A to 64A, 67A to 87A 91A, 94A to 100A.

Litmus milk cultures.—55 per cent. of the streptococc duced acid and clot in milk cultures, namely, as fol —1A to 5A, 31A to 37A, 41A, 46A, 49A, 53A, 55A 59A, 61A to 64A, 67A to 72A, 74A to 88A, 90A to 100

Neutral red broth cultures (anaërobic).—35 per cent. streptococci produced fluorescence in the medium, n as follows:—9A, 28A, 29A, 31A to 35A. 37A, 39A t 43A, 50A, 61A, 71A, 75A to 87A, 89A to 91A, 97A 100A.

Mannite medium.—27 per cent. of the streptococci y positive results, namely, as follows:—31A to 35A, 79A, 81A to 87A, 91A, 97A.

Raffinose medium.—8 per cent. of the streptococci y positive results, namely, as follows:—5A, 28A, 29A 73A, 77A, 80A, 100A.

Inulin medium.—None of the streptococci yielded p results.

The foregoing results may be briefly summarised as follo

Salicin	91	per cent.	positive.
Saccharose	84	,,	,,
Lactose	78	,,	,,
Litmus milk	55	,,	,,
Neutral red	35	,,	,,
Mannite	27	,,	,,
Raffinose	8	,,	,,
Inulin...	none.		

A further analysis of the foregoing table (Table IV.) show the streptococci may be divided into 20 groups, as under:—

Salicin, saccharose, lactose positive, other tests neg 22 per cent., namely, as follows:—6A, 7A, 8A, 10A t 30A.

Salicin, saccharose, lactose, litmus milk, neutral red, mannite positive, other tests negative. 15 per cent., namely, as follows:—32A, 71A, 75A, 76A, 78A, 79A, 81A to 87A, 91A, 97A.

Salicin, saccharose positive, other tests negative. 13 per cent., namely, as follows:—38A, 42A, 45A, 47A, 48A, 51A, 52A, 54A, 56A, 58A, 60A, 65A, 66A.

Salicin, lactose, litmus milk positive, other tests negative. 10 per cent., namely, as follows:—36A, 46A, 49A, 53A, 55A, 57A, 59A, 62A, 63A, 64A.

Salicin, saccharose, lactose, litmus milk, mannite positive, other tests negative. 6 per cent., namely, as follows:—67A to 70A, 72A, 74A.

Salicin, lactose, litmus milk, neutral red, mannite positive, other tests negative. 4 per cent., namely, as follows:—31A, 33A, 34A, 35A.

Salicin, saccharose, lactose, litmus milk positive, other tests negative. 4 per cent., namely, as follows:—1A to 4A.

Salicin, saccharose, neutral red positive, other tests negative. 4 per cent., namely, as follows:—39A, 40A, 43A, 89A.

Saccharose, lactose, litmus milk positive, other tests negative. 4 per cent., namely, as follows:—94A, 95A, 96A, 98A.

Salicin, saccharose, litmus milk, neutral red positive, other tests negative. 3 per cent., namely, as follows:—37A, 41A, 90A.

Saccharose, litmus milk positive, other tests negative. 3 per cent., namely, as follows:—88A, 92A, 93A.

Salicin, saccharose, lactose, litmus milk, neutral red, raffinose positive, other tests negative. 2 per cent., namely, as follows:—80A, 100A.

Salicin, saccharose, lactose, neutral red, raffinose positive other tests negative. 2 per cent., namely, as follows:—28A, 29A.

Salacin, saccharose, lactose, litmus milk, mannite, raffinose positive, other tests negative. 1 per cent., namely, as follows:—77A.

Salicin, saccharose, lactose, litmus milk, raffinose positive, other tests, negative. 1 per cent., namely, as follows:—5A.

Salicin, saccharose, lactose, mannite, 1 per cent. *raffinose* positive, other tests negative. Namely, as follows:—73A.

Salicin, saccharose, lactose, neutral red positive, other tests negative. 1 per cent., namely as follows:—9A.

Salicin, saccharose, neutral red, raffinose positive, other tests negative. 1 per cent., namely, as follows:—50A.

Salicin, lactose, litmus milk, neutral red positive, other tests negative. 1 per cent, namely, as follows :—61A.

Saccharose, lactose, litmus milk, neutral red positive, other tests negative. 1 per cent, namely, as follows :—39A.

[44A yielded negative results as regards all the eight tests.]

Series III.

Streptococci 1B to 100B.

Relative abundance.—The streptococci may be grouped according to the numerical abundance in the following manner:—

$\frac{1}{1000}$ *gramme of faces* :—

1B to 12B (stool XIII.).
50B to 53B (stool XVII.).
54B to 68B (stool XVIII.).
69B, 70B (stool XIX.).

$\frac{1}{10000}$ *gramme of faces* —

13B to 28B (stool XIV.).
29B to 48B (stool XVI.).
49B (stool XVII.).
91B to 100B (stool XX.).

$\frac{1}{100000}$ *gramme of faces* :—

71B to 90B (stool XX.).

Of the 100 streptococci 33, 47, and 20 per cent. were isolated from $\frac{1}{1000}$, $\frac{1}{10000}$, and $\frac{1}{100000}$ respectively of a gramme of faeces.

Broth cultures.—The results may be classified briefly as follows :—

Diffuse cloudiness.—3B to 22B, 29B to 31B, 33B, 37B, 44B. 50B to 54B, 56B to 63B, 65B to 68B, 71B to 100B.

Clear broth with granular masses.—23B to 28B, 36B, 39B. 45B, 55B, 64B, 69B, 70B.

Mixture of diffuse and granular cloudiness.—2B, 34B, 35B, 38B, 40B to 43B, 47B to 49B.

Nearly clear broth with flaky growth at foot of tube.—1B 32B, 46B.

74 per cent. of the streptococci produced diffuse cloudiness in broth culture.

Morphology.—The following broad classification may be of some value :—

Short to medium, but on the whole short chains.—3B to 15B, 22B, 31B, 33B, 34B, 37B, 41B, 44B, 46B to 48B, 50B to 54B, 56B to 63B, 65B to 68B, 71B to 90B, 91B to 100B.

Short to medium, but many chains of medium length.—1B, 2B, 16B to 21B, 29B, 30B, 32B, 35B, 36B, 39B, 40B, 42B, 43B.

Short chains, with some coherence.—23B to 28B, 38B, 45B, 49B, 55B, 64B, 69B, 70B.

It will be noted that 67 per cent. of the streptococci formed short chains without definite coherence.

*Gelatine "streak" cultures.**—The following is a broad statement of the results :—

Minute transparent streptoccus-like colonies.—4B, 9B, 11B, 13B, 15B, 17B to 28B, 30B, 32B to 34B, 36B, 37B, 39B, 46B to 50B, 52B, 53B, 54B to 62B, 64B to 68B, 69B, 70B, 80B, 85B, 89B.

Less minute, more opaque, but still streptococcus-like colonies.—3B, 7B, 12B, 14B, 71B to 79B, 81B to 84B, 86B to 88B, 90B to 100B.

Either no visible growth or practically no growth within 10 days at 20° C.—1B, 2B, 5B, 6B, 8B, 10B, 16B, 29B, 31B, 35B, 38B, 40B to 45B, 51B.

Nitrate broth (two days at 37° C.).—As previously explained none of the 100 streptococci in Series I. and none of the 100 streptococci in Series II. were capable of reducing nitrates to nitrites.

As regards the remaining eight tests, viz., salicin, saccharose, lactose, raffinose, litmus milk, neutral red (anaërobic), inulin, and mannite, the results have been grouped together in a table (Table V.).

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* None of the streptococci liquefied gelatine.

TABLE V.

Showing the biological attributes of 100 streptococci isolat from normal human fæces.

[Series III. Streptococci 1B to 100B.]

	Streptococci.	Salicin. + = acid change (2 days at 37° C.).	Saccharose. + = acid change (2 days at 37° C.).	Lactose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.).	Neutral Red (Anærobic). + = fluorescence (2 days at 37° C.).	Mannite. + = acid change (2 days at 37° C.).	Raffinose. + = acid change (2 days at 37° C.).	Inulin. + = acid chang
1/10000 gramme; stool XIII.	1B	+	+	+	+	+	+	+	o
	2B	+	+	+	+	+	o	+	o
	3B	+	+	+	o	+	+	o	o
	4B	+	+	+	o	o	o	o	o
	5B	+	+	+	+	o	+	+	o
	6B	+	+	+	+	o	o	+	o
	7B	+	+	+	+	o	o	+	o
	8B	+	+	+	+	o	+	+	o
	9B	+	o	o	o	o	o	o	o
	10B	+	+	+	+	o	o	+	o
	11B	+	+	+	+	+	o	+	o
	12B	+	+	+	+	+	o	+	o
1/10000000 gramme; stool XIV.	13B	+	+	o	o	+	o	+	o
	14B	+	+	+	+	+	+	o	o
	15B	+	+	+	+	+	+	o	o
	16B	+	+	o	o	o	o	+	o
	17B	+	o	+	+	+	+	o	o
	18B	+	+	+	+	o	+	o	o
	19B	+	+	o	o	o	o	+	o
	20B	+	+	o	o	o	o	+	o
	21B	+	+	o	o	o	o	+	o
	22B	+	+	+	+	o	o	o	o
	23B	+	+	+	+	+	o	o	o
	24B	+	+	+	+	+	o	o	o
	25B	o	+	+	+	+	o	o	o
	26B	+	+	+	+	+	o	o	o
	27B	+	+	+	+	o	o	o	o
	28B	+	+	+	+	o	o	o	o
	29B	+	+	o	o	+	o	+	+
	30B	o	+	+	+	o	o	+	o
	31B	+	+	+	+	o	o	o	o
	32B	+	+	+	+	o	o	o	o

TABLE V.—*continued.*

Streptococci.		Salicin. + = acid change (2 days at 37° C.).	Saccharose. + = acid change (2 days at 37° C.).	Lactose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.).	Neutral Red (Anaërobic). + = fluorescence (2 days at 37° C.).	Mannite. + = acid change (2 days at 37° C.).	Raffinose. + = acid change (2 days at 37° C.)	Inulin. + = acid change (2 days at 37° C.).
1/100000 gramme, stool XVI.	33B	o	+	+	+	+	o	o	o
	34B	+	+	o	o	o	o	o	o
	35B	o	+	+	+	o	o	o	o
	36B	+	+	o	+	o	o	o	o
	37B	+	+	o	o	o	o	o	o
	38B	+	+	+	+	+	o	o	o
	39B	+	+	+	+	o	o	o	o
	40B	o	+	+	+	o	o	o	o
	41B	+	o	o	o	o	o	o	o
	42B	o	+	+	+	+	o	o	o
	43B	o	+	+	+	o	o	o	o
	44B	+	+	+	+	+	o	o	o
	45B	+	+	+	o	+	+	+	o
	46B	o	+	+	o	o	o	o	o
	47B	o	+	+	+	+	o	o	o
	48B	+	+	+	o	o	o	o	o
1/100000 Ditto.	49B	+	+	o	o	o	o	+	o
1/100000 gramme, stool XVII.	50B	+	+	o	o	+	o	+	+
	51B	+	o	+	+	o	o	o	o
	52B	+	+	+	+	o	o	+	o
	53B	+	+	o	o	o	o	+	o
1/100000 gramme, stool XVIII.	54B	+	o	+	+	o	o	o	o
	55B	+	+	o	o	o	o	o	o
	56B	+	o	+	+	o	o	o	o
	57B	+	o	+	+	o	o	o	o
	58B	+	o	+	+	o	o	o	o
	59B	+	o	+	+	o	o	o	o
	60B	+	o	+	+	o	o	o	o
	61B	+	+	+	+	o	+	o	o
	62B	+	o	+	+	o	o	o	o
	63B	+	+	+	+	+	o	o	o
	64B	+	+	+	o	o	o	o	o
	65B	+	+	+	o	+	+	o	o
	66B	+	o	+	+	o	+	o	o
	67B	+	o	+	+	o	+	o	o
	68B	+	+	+	+	o	+	o	o

TABLE V.—*continued.*

Report on Bacteriological Examination of (1) Excreta of Man: (2) Excreta of Sea-fowl and Fish: and (3) certain Potable Waters: by Dr. Houston.	Streptococci.	Salicin. + = acid change (21 days at 37° C.).	Saccharose. + = acid change (2 days at 37° C.).	Lactose. + = acid change (2 days at 37° C.).	Litmus Milk. + = acid and clot (5 days at 37° C.)	Neutral Red (Anaerobic). + = fluorescence (2 days at 37° C.).	Mannite. + = acid change (2 days at 37° C.).	Raffinose. + = acid change (2 days at 37° C.).	Inulin. + = acid change (5 days at 37° C.).
		+	+	+	+	o	+	o	o
		+	+	+	+	o	+	o	o
		+	+	+	+	+	+	o	o
		+	+	+	+	+	+	o	o
		+	+	+	+	+

The result shown in Table V. may be classified as follows :—

Salicin medium.—91 per cent. of the streptococci yielded positive results, namely, as follows :--1B to 24B, 26B to 29B, 31B, 32B, 34B, 36B to 39B, 41B, 44B, 45B, 48B to 100B.

Saccharose medium.—86 per cent. of the streptococci yielded positive results, namely, as follows :—1B to 8B, 10B to 16B, 18B to 40B, 42B to 50B, 52B, 53B, 55B, 61B, 63B to 65B, 68B to 89B, 91B to 100B.

Lactose medium.—85 per cent. of the streptococci yielded positive results, namely, as follows :—1B to 8B, 10B to 12B, 14B, 15B, 17B, 18B, 22B to 28B, 30B to 33B, 35B, 38B to 40B, 42B to 48B, 51B, 52B, 54B, 56B to 100B.

Litmus milk cultures.—79 per cent. of the streptococci yielded acid and clot in litmus milk cultures, namely, as follows : —1B, 2B, 5B to 8B, 10B to 12B, 14B, 15B, 17B, 18B, 22B to 28B, 30B to 33B, 35B, 36B, 38B to 40B, 42B to 44B, 47B, 51B, 52B, 54B, 56B to 63B, 66B to 100B.

Neutral red broth test (anaërobic).—48 per cent. of the streptococci produced fluorescence in this medium, namely, as follows :—1B, 2B, 3B, 11B to 15B, 17B, 23B to 26B, 29B, 33B, 42B, 44B, 45B, 47B, 50B, 63B, 65B, 70B, 72B to 84B, 86B, 87B, 90B to 98B.

Mannite medium.—39 per cent. of the streptococci yielded positive results, namely, as follows :—1B, 3B, 5B, 8B, 14B, 15B, 17B, 18B, 45B, 61B, 65B to 68B, 71B to 73B, 75B, 76B, 78B, 79B, 81B to 85B, 87B, 88B, 90B to 100B.

Raffinose medium.—26 per cent. of the streptococci yielded positive results, namely, as follows :—1B, 2B, 5B to 8B, 10B to 13B, 16B, 19B to 21B, 29B, 30B, 45B, 49B, 50B, 52B, 53B, 70B, 77B, 80B, 86B, 89B.

Inulin medium.—2 per cent. of the streptococci yielded positive results, namely :—29B, 50B.

The foregoing results may be briefly summarised as follows :—

Salicin ...	...	...	...	91 per cent.	positive.
Saccharose	...	...	...	86 „	„
Lactose ...	...	...	...	85 „	„
Litmus milk	...	...	...	79 „	„
Neutral red	...	...	...	48 „	„
Mannite	...	...	...	39 „	„
Raffinose	...	...	...	26 „	„
Inulin ...	...	...	...	2 „	„

A further analysis of the foregoing table (Table V.) shows that the streptococci may be divided into 24 groups as follows :—

Salicin, saccharose, lactose, litmus milk, neutral red, mannite positive, other tests negative, 21 per cent., namely, as

follows :—14B, 15B, 72B, 73B, 75B, 76B, 78B, 79B, 81B to 84B, 87B, 91B to 97B, 98B.

Salicin, *saccharose*, *lactose*, *litmus milk*, *mannite* positive, other tests negative, 8 per cent., namely, as follows :—18B, 61B, 68B, 71B, 85B, 88B, 99B, 100B.

Salicin, *lactose*, *litmus milk* positive, other tests negative, 8 per cent., namely, as follows :—51B, 54B, 56B to 60B, 62B.

Salicin, *saccharose*, *lactose*, *litmus milk*, *neutral red*, *raffinose* positive, other tests negative, 7 per cent., namely, as follows :—2B, 11B, 12B, 70B, 77B, 80B, 86B.

Salicin, *saccharose*, *lactose*, *litmus milk*, *neutral red* positive, other tests negative, 7 per cent., namely, as follows :—23B, 24B, 26B, 38B, 44B, 63B, 74B.

Salicin, *saccharose*, *lactose*, *litmus milk* positive, other tests negative, 7 per cent., namely, as follows :—22B, 27B, 28B, 31B, 32B, 39B, 69B.

Salicin, *saccharose*, *raffinose* positive, other tests negative, 6 per cent., namely, as follows :—16B, 19B, 20B, 21B, 49B, 53B.

Salicin, *saccharose*, *lactose*, *litmus milk*, *raffinose* positive, other tests negative, 5 per cent., namely, as follows :—6B, 7B, 10B, 52B, 89B.

Saccharose, *lactose*, *litmus milk*, *neutral red* positive, other tests negative, 4 per cent., namely, as follows :—25B, 33B, 42B, 47B.

Saccharose, *lactose*, *litmus milk* positive, other tests negative, 3 per cent., namely, as follows :—35B, 40B, 43B.

Salicin, *saccharose*, *lactose* positive, other tests negative, 3 per cent., namely, as follows :—4B, 48B, 64B.

Salicin, *saccharose* positive, other tests negative, 3 per cent., namely, as follows :—34B, 37B, 55B.

Salicin, *saccharose*, *lactose*, *litmus milk*, *mannite*, *raffinose* positive, other tests negative, 2 per cent., namely, as follows :—5B, 8B.

Salicin, *saccharose*, *lactose*, *neutral red*, *mannite* positive, other tests negative, 2 per cent., namely, as follows :—3B, 65B.

Salicin, *lactose*, *litmus milk*, *neutral red*, *mannite* positive, other tests negative, 2 per cent., namely, as follows :—17B, 90B.

Salicin, *saccharose*, *neutral red*, *raffinose*, *inulin* positive, other tests negative, 2 per cent., namely, as follows :—29B, 50B.

Salicin, *lactose*, *litmus milk*, *mannite* positive, other tests negative, 2 per cent., namely, as follows : –66B, 67B.

Salicin positive, other tests negative, 2 per cent., namely, as follows :—9B, 41B.

Salicin, *saccharose*, *lactose*, *litmus milk*, *neutral red*, *mannite*, *raffinose* positive, other tests negative, 1 per cent., namely, as follows :—1B.

Salicin, *saccharose*, *lactose*, *neutral red*, *mannite*, *raffinose* positive, other tests negative, 1 per cent., namely, as follows :—45B.

Salicin, *saccharose*, *neutral red*, *raffinose* positive, other tests negative, 1 per cent., namely, as follows :—13B.

Saccharose, *lactose*, *litmus milk*, *raffinose* positive, other tests negative, 1 per cent., namely, as follows :—30B.

Salicin, *saccharose*, *litmus milk* positive, other tests negative, 1 per cent., namely, as follows :—36B.

Salicin, *lactose* positive, other tests negative, 1 per cent., namely, as follows :—46B.

Before proceeding to consider the results of certain experiments as regards the vitality of streptococci in water it is desirable to try and bring the foregoing three series of experiments into line.

Summary as regards the foregoing three series of experiments (Streptococci 1 to 100, 1A to 100A, 1B to 100B).

Relative abundance.—The number of streptococci per gramme of fæces was enormous, 29 per cent., 58 per cent., 8 per cent., and 5 per cent. of the streptococci were isolated from $\frac{1}{100000}$, $\frac{1}{1000000}$, $\frac{1}{10000000}$, $\frac{1}{100000000}$ respectively of a gramme of fæces. A safe estimate of the average number of streptococci per gramme of normal human fæces would seem to be, on the foregoing basis, at least 100,000 to a million. These figures may be borne in mind in relation to the bacteriological examination of potable waters for evidence of objectionable pollution.

Broth cultures.—75 per cent. of the streptococci produced diffuse cloudiness in broth cultures.

Gelatine "streak" cultures.—The great majority of the streptococci grew as minute transparent-looking colonies in gelatine "streak" cultures. None of them liquefied gelatine.

Pathogenicity.—The results (*see* Series I.) were wholly negative.

Nitrate broth test.—None of the 200 streptococci tested (*see* Series II. and III.) reduced nitrates to nitrites. [All the 100 fæcal B. coli dealt with in last year's result in this sense.]

As regards the salicin, saccharose, lactose, raffinose, litmus milk, neutral red (anaërobic), inulin, and mannite tests the results were as follows:—

Test.	Series I. +	Series II. +	Series III. +	Average +
	Per cent.	Per cent.	Per cent.	Per cent.
Salicin	96	91	91	92·67
Saccharose	89	84	[illegible]	86·34
Lactose	66	78	85	76·34
Litmus milk	51	55	79	61·67
Neutral red broth ...	35	95	48	39·34
Raffinose	62	8	26	32·00
Mannite	7	27	39	24·34
Inulin	12	None.	2	4·67

Turning next to the grouping of the 300 streptococci, it appears on analysis of the foregoing results that they fall under no less than 40 separate groups on the basis of the tests employed. It is not suggested, however, that this necessarily means 40 distinct species.

It needs to be remembered that the "change" produced by the streptococci in the sugar media and recorded as a positive result is merely an acid change. In the case of B. coli the acid change is accompanied by copious gas formation. The production of gas as well as acid would seem to be a more reliable biological feature to rely on for differential purposes than formation of acid alone.

The fact of there being so many groups unfortunately suggests the likelihood of streptococci isolated from various and perhaps unobjectional sources falling almost necessarily under one or other of the 40 groups now to be designated according to the positive reactions characterising them, and with note in each instance of the percentage of streptococci of Series I., II., and III., which found inclusion in the group.

I.—*Salicin, saccharose, lactose, litmus milk, neutral red, mannite group.*

Series I., 3 per cent.; Series II., 15 per cent.; Series III., 21 per cent. Average, 13 per cent.

II.—*Salicin, saccharose, lactose group.*

Series I., 1 per cent.; Series II., 22 per cent.; Series III., 3 per cent. Average, 8·67 per cent.

III.—*Salicin, saccharose, lactose, litmus milk, raffinose group.*

Series I., 18 per cent.; Series II., 1 per cent.; Series III. 5 per cent. Average, 8 per cent.

IV.—*Salicin, saccharose, lactose, litmus milk group.*

Series I., 11 per cent.; Series II., 4 per cent.; Series III., 7 per cent. Average, 7·34 per cent.

V.—*Salicin, saccharose group.*

Series I., 5 per cent.; Series II., 13 per cent; Series III., 3 per cent. Average, 7 per cent.

VI.—*Salicin, lactose, litmus milk group.*

Series I., 2 per cent.; Series II., 10 per cent; Series III., 8 per cent. Average, 6·67 per cent.

VII.—*Salicin, saccharose, raffinose group.*

Series I., 13 per cent.; Series II., none; Series III., 6 per cent. Average, 6·34 per cent.

VIII.—*Salicin, saccharose, lactose, raffinose, neutral red group.*

Series I., 14 per cent.; Series II,, 2 per cent.; Series III., none. Average, 5·34 per cent.

IX.—*Salicin, saccharose, lactose, litmus milk, mannite group.*

Series I., none; Series II., 6 per cent.; Series III., 8 per cent. Average, 4·67 per cent.

X.—*Salicin, saccharose, lactose, raffinose, litmus milk, neutral red group.*

Series I., 2 per cent.; Series II., 2 per cent.; Series III., 7 per cent. Average, 3·67 per cent.

XI.—*Salicin, saccharose, lactose, litmus milk, neutral red group.*

Series I., 3 per cent.; Series II., none; Series III., 7 per cent. Average, 3·34 per cent.

XII.—*Saccharose, lactose, litmus milk group.*

Series I., 1 per cent.; Series II., 4 per cent.; Series III., 3 per cent. Average, 2·67 per cent.

XIII.—*Salicin, lactose, litmus mil*

Series I., 5 per
Series III.

XIV.—*Salicin, lactose, litmus milk, neutral red, mannite group.*

Series I., none; Series II., 4 per cent.; Series III., 2 per cent. Average, 2 per cent.

XV.—*Saccharose, lactose, litmus milk, neutral red group.*

Series I., 1 per cent.; Series II., 1 per cent.; Series III., 4 per cent. Average, 2 per cent

XVI.—*Salicin, saccharose, raffinose, inulin group.*

Series I., 5 per cent.; Series II., none; Series III., none. Average, 1·67 per cent.

XVII.—*Salicin, saccharose, raffinose, neutral red, inulin group.*

Series I., 3 per cent.; Series II., none; Series III., 2 per cent. Average, 1·67 per cent.

XVIII.—*Salicin, saccharose, neutral red group.*

Series I., none; Series II., 4 per cent.; Series III., none. Average, 1·34 per cent.

XIX.—*Saccharose, litmus milk group.*

Series I., 1 per cent.; Series II., 3 per cent.; Series III., none. Average, 1·34 per cent.

XX.—*Salicin, saccharose, lactose, neutral red, mannite group.*

Series I., 2 per cent.; Series II., none; Series III., 2 per cent. Average, 1·34 per cent.

XXI.—*Saccharose, lactose, litmus milk, neutral red group.*

Series I., none; Series II., none: Series III., 4 per cent. Average, 1·34 per cent.

XXII.—*Salicin, raffinose group.*

Series I., 3 per cent.; Series II., none; Series III., none. Average, 1 per cent.

XXIII.—*Salicin, saccharose, litmus milk, neutral red group.*

Series I., none; Series II., 3 per cent.; Series III., none. Average, 1 per cent.

XXIV.—*Salicin, saccharose, lactose, litmus milk, mannite, raffinose group.*

Series I., none; Series II., 1 per cent.; Series III., 2 per cent. Average, 1 per cent.

XXV.—*Salicin, saccharose, litmus milk group.*

Series I., 1 per cent.; Series II., none; Series III., 1 per cent. Average, 0·67 per cent.

XXVI.—*Salicin, saccharose, neutral red, raffinose group.*

Series I., none; Series II., 1 per cent.; Series III., 1 per cent. Average, 0·67 per cent.

XXVII.—*Salicin, lactose, litmus milk, mannite group.*

Series I., none; Series II., none; Series III., 2 per cent. Average, 0·67 per cent.

XXVIII.—*Salicin, saccharose, raffinose, inulin, mannite group.*

Series I, 1 per cent.; Series II., none; Series III., none. Average, 0·34 per cent.

XXIX.—*Salicin, saccharose, lactose, litmus milk, neutral red, inulin group.*

Series I., 1 per cent.; Series II., none; Series III., none. Average, 0·34 per cent.

XXX.—*Saccharose, raffinose group.*

Series I., 1 per cent.; Series II., none; Series III., none. Average, 0·34 per cent.

XXXI.—*Salicin, saccharose, inulin group.*

Series I., 1 per cent.; Series II., none; Series III., none. Average, 0·34 per cent.

XXXII.—*Salicin, lactose, raffinose, litmus milk, neutral red group.*

Series I., 1 per cent.; Series II,, none; Series III., none. Average, 0·34 per cent.

XXXIII.—*Salicin, saccharose, lactose, raffinose, litmus milk, inulin, mannite group.*

Series I., 1 per cent.; Series II., none; Series III., none. Average, 0·34 per cent.

XXXIV.—*Salicin, saccharose, lactose, neutral red group.*

Series I., none; Series II., 1 per cent.; Series III., none. Average, 0·34 per cent.

XXXV.—*Salicin, saccharose, lactose, mannite, raffinose group.*

Series I., none; Series II., 1 per cent.; Series III., none. Average, 0·34 per cent.

XXXVI.—*Salicin, saccharose, lactose, litmus milk, neutral red, mannite, raffinose group.*

Series I., none; Series II., none; Series III., 1 per cent. Average, 0·34 per cent.

XXXVII.—*Salicin group.*

Series I., none; Series II., none; Series, III. 1 per cent. Average, 0·34 per cent.

XXXVIII.—*Saccharose, lactose, litmus milk, raffinose group.*

Series I., none; Series II., none; Series III., 1 per cent. Average, 0·34 per cent.

XXXIX.—*Salicin, saccharose, lactose, neutral red, mannite, raffinose group.*

Series I., none; Series II., none; Series III., 1 per cent. Average, 0·34 per cent.

XL.—*Salicin, lactose group.*

Series I., none; Series II., none; Series III., 1 per cent. Average, 0·34 per cent.

The large number of separate groups which, on the basis of the tests employed, has been forthcoming is somewhat surprising. In this connection it needs to be remembered that the successful subculturing of streptococci is not so certain a procedure as is the case with most other microbes. But allowing for occasional error, it is obvious that the streptococci in fæces constitute a race of microbes differing widely in their biological attributes. Unfortunately with so many groups to select from a particular streptococcus or pseudo-streptococcus derived from a non-fæcal source could hardly fail to fall under one or another of the 40 groups of fæcal streptococci.

If it were arbitrarily decided to ignore all those streptococci falling under the groups whose numerical value was less than three per cent., and at the same time to dispense with the salicin and inulin tests,* it would be possible to account for about 74 per cent. of the streptococci within the limits of ten groups. Of course this might mean ignoring some streptococci which, above their fellows, are characteristic of human fæces. But from the practical point of view it is convenient to consider, if only tentatively, such arbitrary arrangement as tending in the direction of simplicity. Thus :—

Group A.—Positive: *saccharose, lactose, litmus milk;* negative: *neutral red, raffinose,* and *mannite.* 10 per cent.

Group B.—Positive: *saccharose, lactose, litmus milk, neutral red;* negative: *raffinose* and *mannite.* 7 per cent.

Group C.—Positive: *saccharose, lactose, litmus milk, raffinose;* negative: *neutral red* and *mannite.* 8·34 per cent.

Group D.—Positive: *saccharose, lactose, litmus milk, mannite;* negative: *neutral red* and *raffinose.* 4·67 per cent.

Group E.—Positive: *saccharose, lactose, litmus milk, neutral red, raffinose;* negative: *mannite.* 3·67 per cent.

Group F.—Positive: *saccharose, lactose, litmus milk, neutral red, mannite;* negative: *raffinose.* 13 per cent.

* The salicin test is perhaps too universal and the inulin test too exclusive to be useful for purposes of differentiation. On the other hand there may prove to be good grounds for retaining the salicin test.

Group G.—Positive: *saccharose, lactose;* negative: *litmus milk, neutral red, raffinose,* and *mannite.* 8·67 per cent.

Group H.—Positive: *saccharose, raffinose;* negative: *lactose, litmus milk, neutral red,* and *mannite.* 6·68 per cent.

Group I.—Positive: *saccharose, lactose, raffinose, neutral red;* negative: *litmus milk* and *mannite.* 5·34 per cent.

Group J.—Positive: *lactose, litmus milk;* negative: *saccharose, raffinose, neutral red,* and *mannite.* 6·67 per cent.

It is to be observed, however, that the foregoing arrangement leaves about 26 per cent. of the streptococci unaccounted for. Moreover, my most recent work leads me to consider that the salicin test may be of definite value in the following sense:—Over 90 per cent. of the fæcal streptococci produce an acid change in salicin. Many of the minute colonies, liable to be mistaken for streptococci, occurring in plate cultures made from waters are found on further study not to be true streptococci. As a minority only of these water pseudo-streptococci "change" the salicin medium, it is obvious that it might be desirable to utilise the salicin as a preliminary test and reject all the microbes which showed no acid change.

Up to the present only those streptococci have been considered which do not liquefy gelatine. It is necessary to add a brief description of a few streptococci or pseudo-streptococci which were found to be liquefiers.

The following is a description of their biological characters:—

Liquefying Streptococci or Pseudo-streptococci.

Microbe.	I.	II.	III.	IV.	V.	VI.	VII.
Source	All from one-millionth of a gramme of stool XI.						
Morphology	All short chains of cocci simulating in their appearance true streptococci.						
Neutral red broth (anaërobic).	+	+	+	+	+	+	+
Lactose test	+	+	+	+	+	+	+
Saccharose test ..	+	+	+	+	+	+	+
Mannite test	+	+	+	+	+	+	+
Inulin test	-	-	-	-	-	-	-
Salicin test	+	+	+	+	+	+	+
Raffinose test	+	-	-	-	-	-	-
Litmus milk	Acid, clot and peptonisation.	Acid, clot and peptonisation.	Acid, clot and peptonisation.	Acid, clot and peptonisation.	Acid, clot and peptonisation.	Acid, clot and peptonisation.	Acid, clot and peptonisation.
Nitrate broth	None of them reduced nitrates to nitrites.						
Broth cultures ..	Diffuse cloudiness.	Diffuse cloudiness.	Diffuse cloudiness.	Diffuse cloudiness.	Diffuse cloudiness.	Diffuse cloudiness.	Diffuse cloudiness

E. *The Vitality of Fæcal Streptococci.*

When first I drew attention to the possible value of the streptococcus test in connection with the bacterioscopic analysis of potable waters* I was careful to note what might be some of its shortcomings. For example, I specially stated that *all* streptococci were not necessarily delicate germs and of feeble vitality. My main point was that as streptococci are superabundant in sewage and in excremental matter, and absent or present only in sparse amount in pure waters, the *primâ facie* presumption was in favour of the streptococcus test being of use in the bacterioscopic analysis of potable waters.

Since then much work has been done, and on the whole the results have gone to confirm my original views. But it needs to be borne in mind that there is a great difference between a test which is inherently good and one which is of proved practical utility. To attain the latter end the combined researches of many independent observers might be required over a prolonged period. Even at the present day the comparatively simple B. coli test is not without a host of detractors. Yet in connection with the B. coli test more strenuous work has been carried out than as regards probably any other known test.

The chief source of trouble experienced in respect of the streptococcus test has been the almost insuperable difficulties attending the differentiation of species. If it becomes possible to sift with comparative ease and certainty the streptococci into definite groups and to assign to each group a precise significance as regards objectionable pollution a great advance will have been made. It is in my opinion lack of knowledge rather than intrinsic inferiority that at present operates against the practical usefulness of the streptococcus test.

In what follows I give evidence strongly indicative of a rapid loss of vitality of a few streptococci, and evidence also that many fæcal streptococci can maintain their existence under laboratory conditions of experiment for a surprisingly long time. Unfortunately I am unable at present to suggest any biological tests other than the actual test of viability which would enable the bacteriologist to differentiate with any degree of certainty the less hardy streptococci from their more robust fellows.

Vitality of Fæcal Streptococci† in Sterilized Tap Water kept in Stoppered Bottles in the dark at 20° C.

Twenty-five separate streptococci were tested. The procedure in each case was as follows:—300 cc. of sterile tap water contained in a stoppered bottle were inoculated with an agar culture of a single streptococcus. After vigorous shaking the initial number of streptococci was determined by making a series of dilutions and inoculating broth tubes with a definite amount from each dilution. The bottle was then placed in an

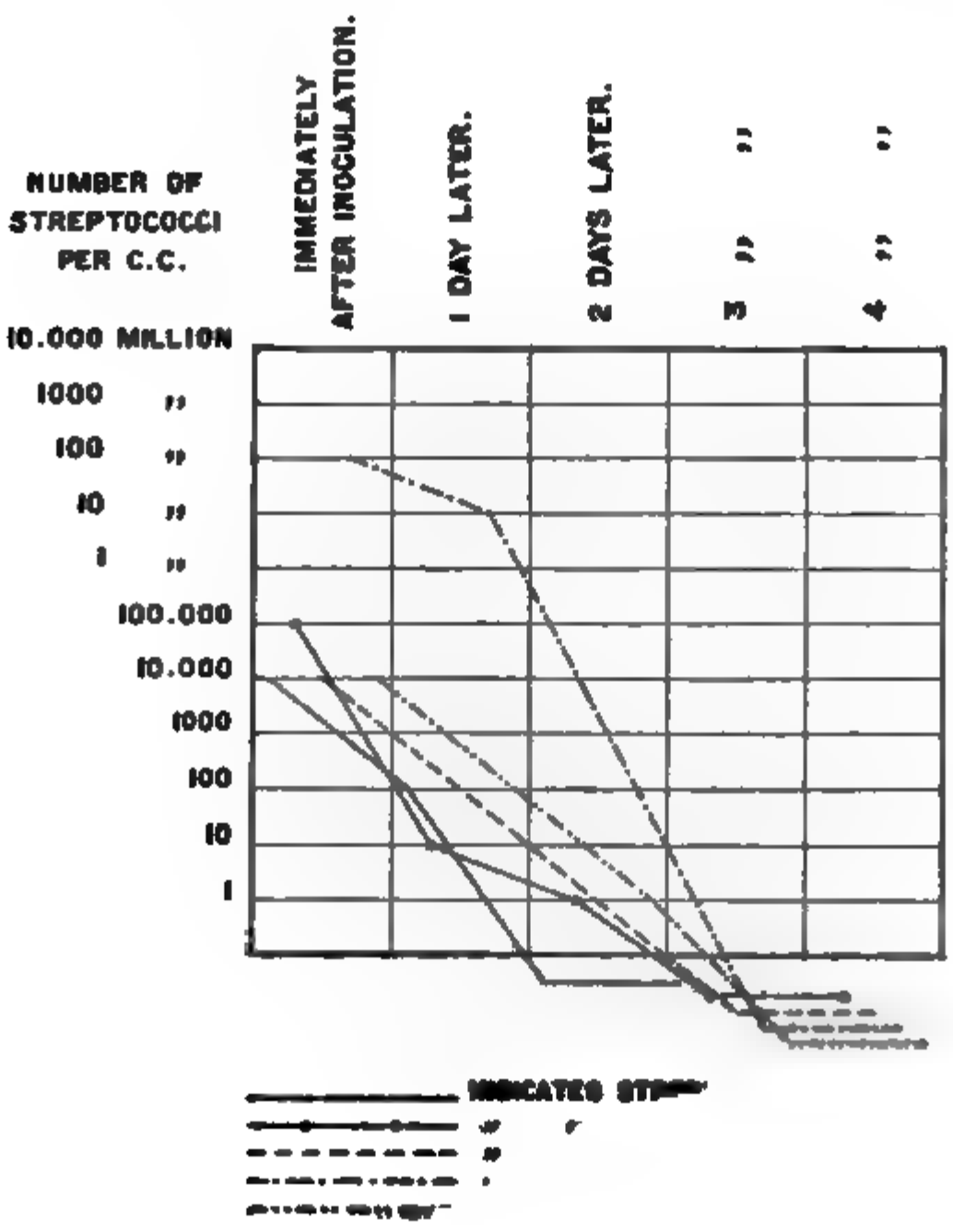
* Report of the Medical Officer, Local Government Board, 1898-9.

† The cultural characters of the streptococci employed in these experiments have already been set forth in detail.

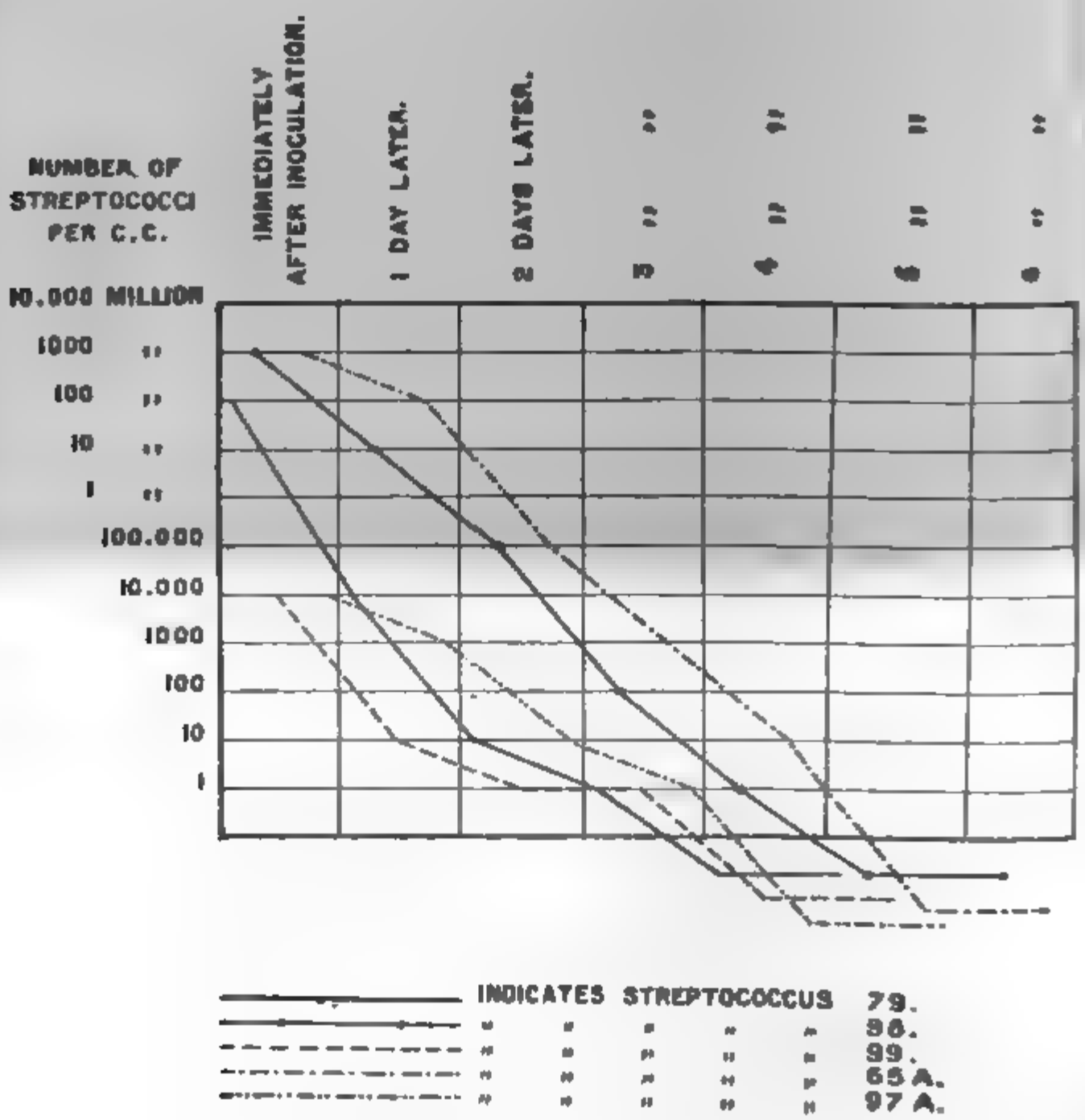
incubator at 20° C. These and subsequent broth cultures were incubated at 37° C. for two to three days and then examined microscopically. Each day the bottle was removed from the incubator, shaken, further dilutions made, and broth cultures inoculated therewith. In this manner the number of streptococci in the water was estimated day by day. When on two successive days the 1 cc. broth cultures made from the bottle failed to develop any growth after incubation at 37° C. for three days, the streptococcus was considered to be, for practical purposes, dead. Of course failure to obtain growth with 1 cc. need not necessarily always mean that a similar result would have been obtained if a larger volume of the water had been submitted to examination. But it certainly signifies the relative disappearance of the streptococcus from the water and perhaps for all practical purposes its death.

The results may be grouped arbitrarily as follows :—

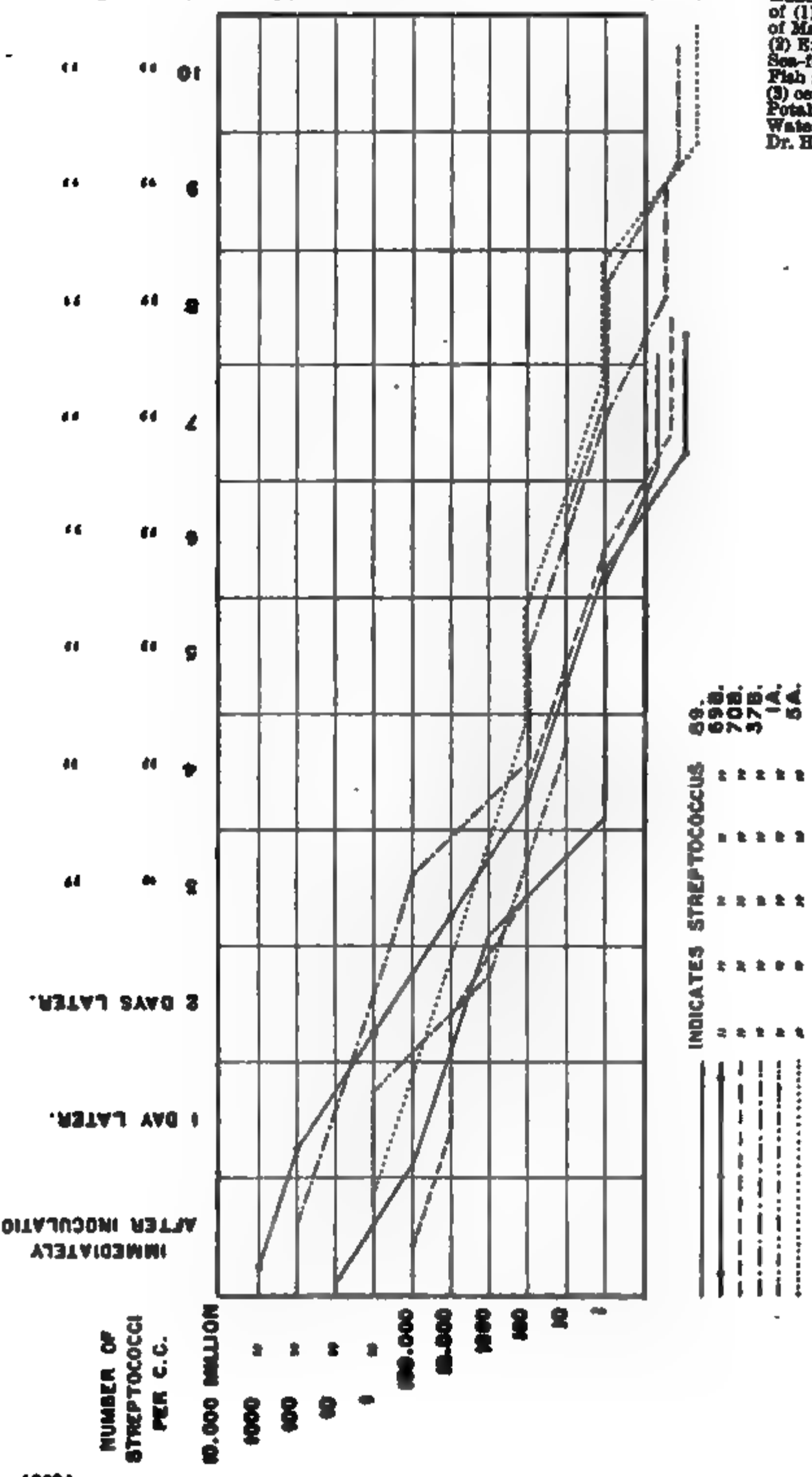
GROUP I.—In this group are included the streptococci which died either on the 2nd or 3rd day after inoculation of the sterile tap water, namely, streptococci 95A, 69, 96, 97, and 100.



Group II.—This group comprises the streptococci which died either on the 4th or 5th day after inoculation of the sterile tap water, namely, streptococci 79, 98, 99, 65A, 97A.



GROUP III.—This group includes the streptococci which died on the 7th, 8th, or 9th day after inoculation of the sterile tap water, namely, streptococci 89, 69B, 70B, 37A, 1A, 5A.



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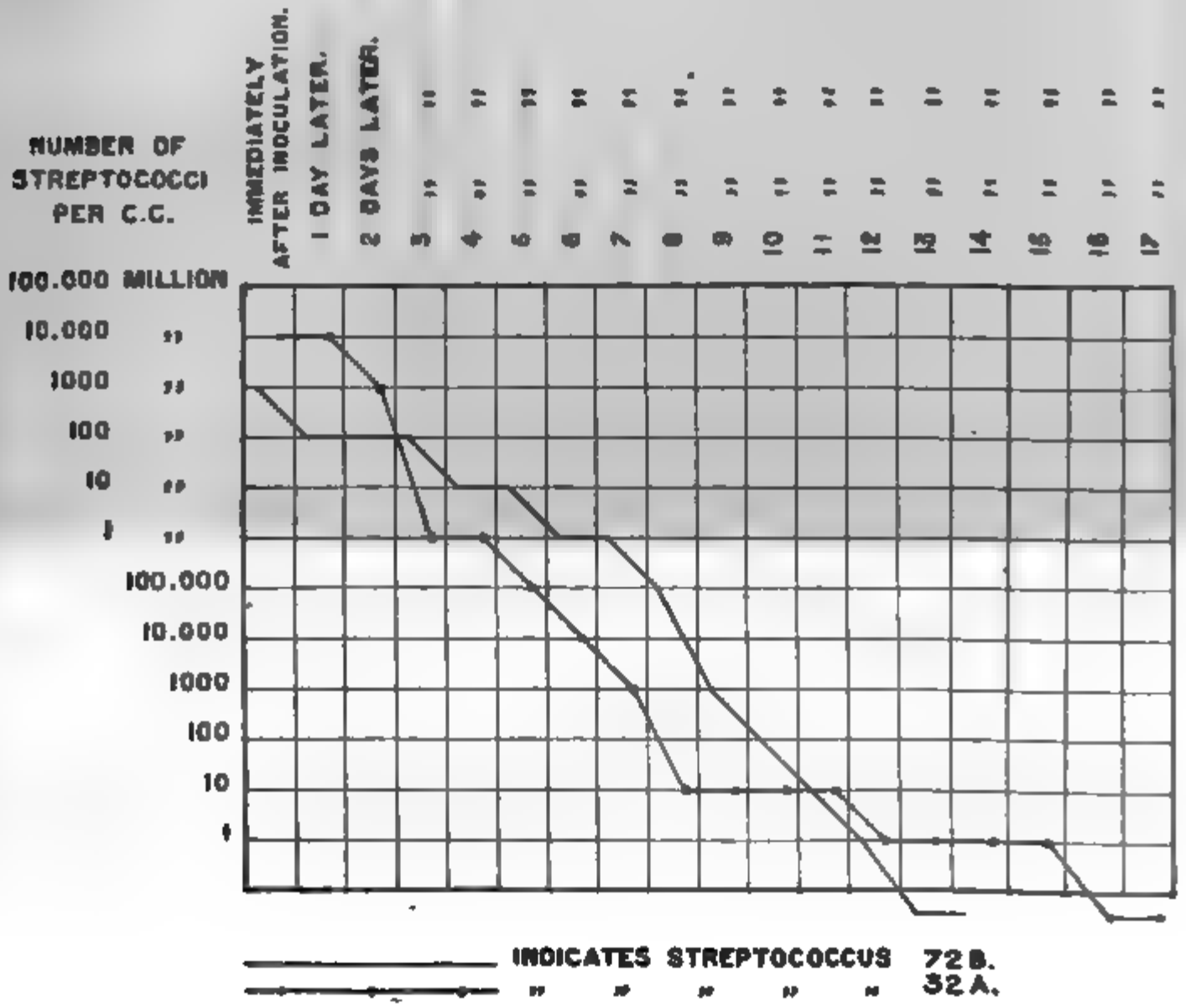
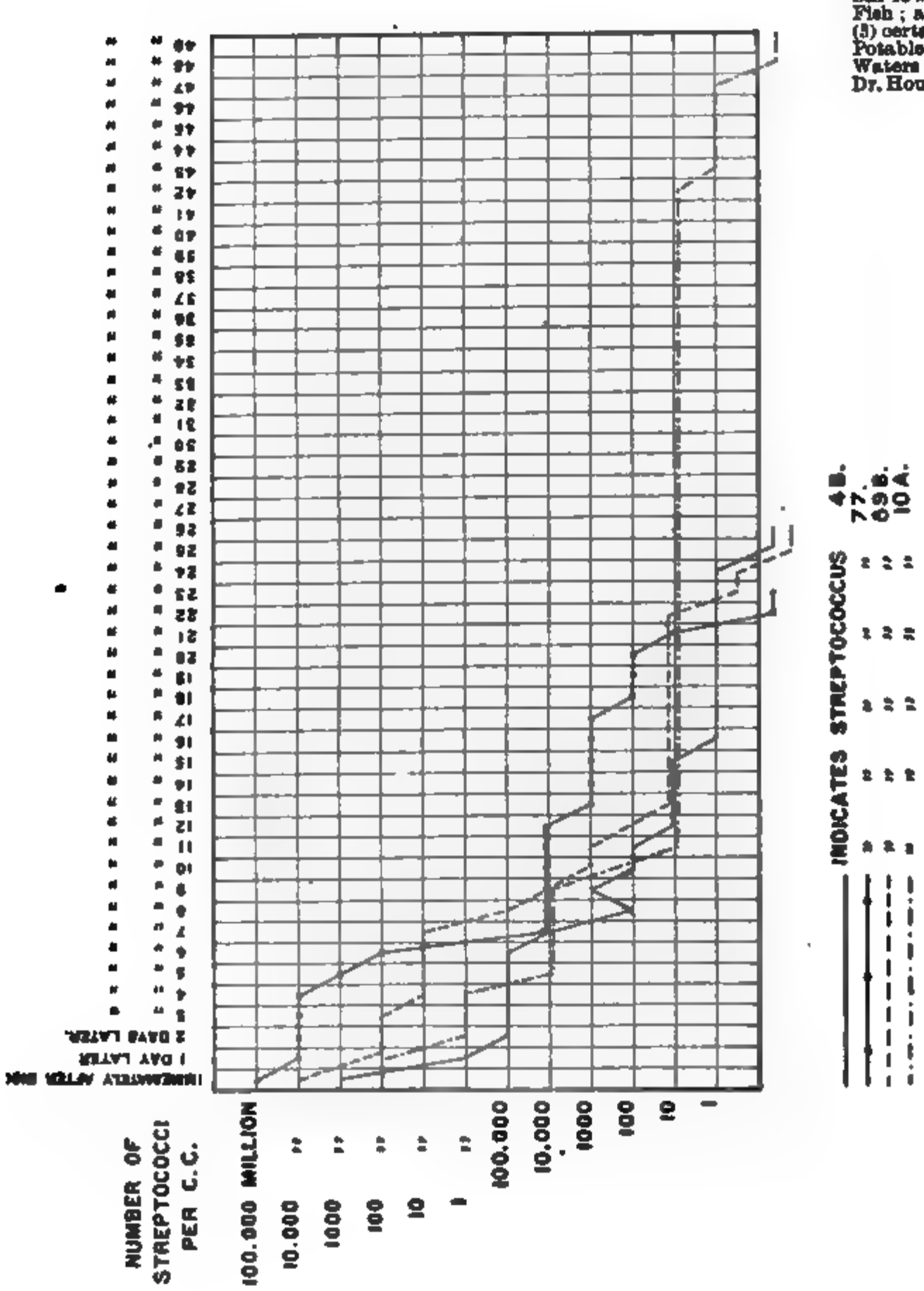
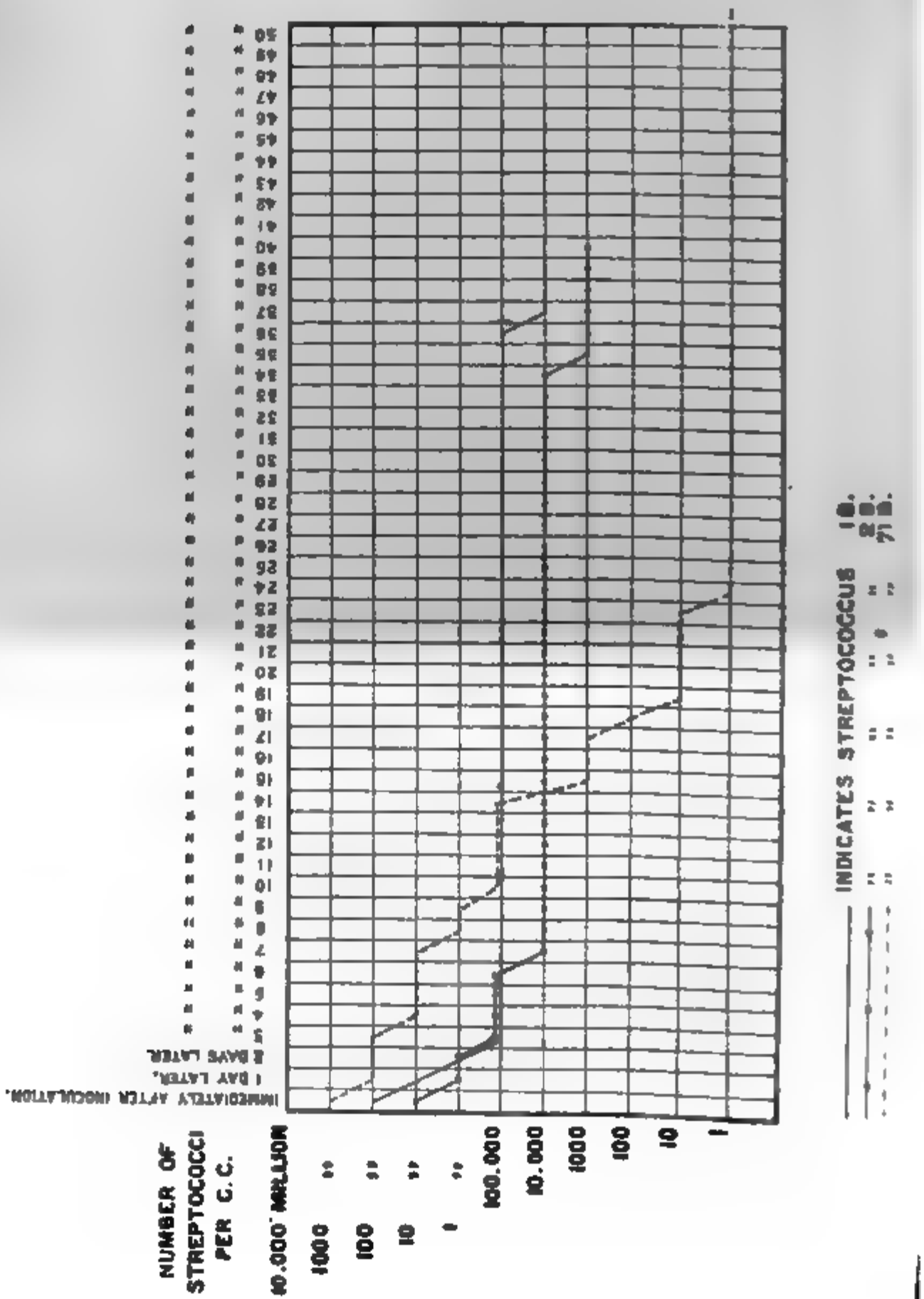
GROUP IV.—In this group are included the two streptococci which died on the 13th and 16th day after inoculation of the sterile tap water, namely, streptococci 72B and 32A respectively.



GROUP V.—This group includes streptococci 4B, 77, 89B, and 10A, which died on the 22nd, 25th, and 48th day respectively after inoculation of the sterile tap water.



GROUP VI.—This group comprises streptococci 1B, 2B, and 71B, which on the 38th, 40th, and 51st day respectively after inoculation of the sterile tap water were still alive.



In summary of the foregoing it is to be noted that—

4	per cent.	of the	25	streptococci	died in	2 days.
16	,,	,,	,,	,,	3	,,
12	,,	,,	,,	,,	4	,,
8	,,	,,	,,	,,	5	,,
12	,,	,,	,,	,,	7	,,
4	,,	,,	,,	,,	8	,,
8	,,	,,	,,	,,	9	,,
4	,,	,,	,,	,,	13	,,
4	,,	,,	,,	,,	16	,,
4	,,	,,	,,	,,	22	,,
8	,,	,,	,,	,,	25	,,
4	,,	,,	,,	,,	48	,,
4	,,	,,	,,	did not die in	38	,,
4	,,	,,	,,	,,	40	,,
4	,,	,,	,,	,,	51	,,

Thus, under the conditions of experiment 64 per cent. of the streptococci died within 10 days.

It will be noted by reference to the diagrams that the initial number of streptococci added to the water in the different bottles varied from 10,000 per cc. to 100,000 million per cc. Further, that in nearly all cases there was a rapid and marked decline in number of the streptococci short of their actual disappearance from 1 cc. of the water.

It is obvious from the foregoing experiments that *some fæcal streptococci speedily die when planted in sterilised tap water.* Hence, if it were possible by cultural or other tests to differentiate with certainty these streptococci from their more hardy fellows, a decided step would have been made in the direction of detecting evidence of *recent* pollution. Unfortunately at present, beyond the actual testing of the viability of the streptococci in water, no tests seem to afford the necessary information; for it has been found that streptococci yielding the same results to cultural tests do not necessarily yield similar results as regards viability.

It must also be remembered that the results obtained under laboratory conditions of experiment and when working with sterilised tap water may be widely different from those pertaining to natural conditions and waters of diverse sort.

Vitality of Fæcal Streptococci in Sterile Salt Solution (0·5 gramme *sodium chloride* in 95·5 cc. distilled water).*

The procedure was as follows :—

A tube containing 10 cc. of sterile salt solution was in each case inoculated with a platinum loopful of a broth culture of

* It should be noted that this "physiological salt solution" contained much more salt than is present in natural drinking waters. For example, moorland water usually contains about one part of chlorine per 100,000 parts of water. In the solution used for these experiments the proportion of sodium chloride was *500 parts in 100,000* parts of water, or one part in 200 parts.

App. B, No. 7.

Report on Bacteriological Examination of (1) Excreta of Man, (2) Excreta of Sea-fowl and Fish, and (3) certain Potable Waters; by Dr. Houston.

the particular streptococcus of experiment. After shaking the tube, 0·1 cc. of the saline solution was removed with a sterile pipette and a broth culture made. The broth culture was incubated at 37° C. for 2 to 3 days, and then examined microscopically to determine the presence of living streptococci in this amount of saline solution (0·1 cc.). The tube containing the saline and streptococcus was placed in an incubator at 20° C. On the 2nd, 4th, 6th, 8th, 10th, and 20th day 1 cc. broth cultures were made from the tube. It will be noted that in testing for the viability of the streptococcus ten times more of the saline solution was used than had been employed in the initial culture.

One hundred streptococci (1B to 100B)* were tested in the above manner, each in a separate tube. The results are shown in the following table:—

TABLE VI.

Showing the viability of fæcal streptococci in sterile salt solution.

Streptococcus.	Immediately after inoculation, present in ½ cc.	2 days later, present in 1 cc.	4 days later, present in 1 cc.	6 days later, present in 1 cc.	8 days later, present in 1 cc.	10 days later, present in 1 cc.	20 days later, present in 1 cc.
1B	+	+	+	+	+	+	+
2B	+	+	+	+	+	+	+
3B	+	+	+	+	+	+	+
4B	+	+	+	+	o		
5B	+	+	+	+	o		
6B	+	+	+	+	o		
7B	+	+	+	+	+	+	+
8B	+	+	+	+	o		
9B	+	+	+	+	+	+	+
10B .. .	+	+	+	+	+	+	+
11B	+	+	+	+	+	+	+
12B	+	+	+	+	+	+	+
13B	+	+	+	+	+	+	+
14B	+	+	+	+	+	+	+
15B	+	+	+	+	+	+	+
16B	+	+	+	o			
17B	+	+	+	+	+	+	+
18B	+	+	+	+	+	+	+
19B	+	+	o				
20B	+	+	o				

* The biological characters of these streptococci have been already considered.

TABLE VI.—*continued.*

Streptococcus.	Immediately after inoculation, present in $\frac{1}{10}$ cc.	2 days later, present in 1 cc.	4 days later, present in 1 cc.	6 days later, present in 1 cc.	8 days later, present in 1 cc.	10 days later, present in $\frac{1}{10}$ cc.	20 days later, present in $\frac{1}{10}$ cc.
21B	+	+	+	+	o		
22B	+	+	+	+	+	+	+
23B	+	+	+	+	+	+	+
24B	+	+	+	+	+	+	+
25B	+	+	+	o			
26B	+	+	+	+	o		
27B	+	+	o				
28B	+	+	+	o			
29B	+	+	+	+	o		
30B	+	+	+	+	+	o	+
31B	+	+	+	+	+	+	o
32B	+	+	+	+	o		
33B	+	+	+	+	+	+	+
34B	+	+	+	+	o	+	+
35B	+	+	+	o			
36B	+	+	+	+	+	o	
37B	+	+	+	+	o		
38B	+	+	+	o			
39B	+	+	+	+	+	+	o
40B	+	+	+	+	+	o	
41B	+	+	+	+	+	+	o
42B	+	+	+	+	+	+	+
43B	+	+	+	+	+	o	
44B	+	+	+	+	+	+	o
45B	+	+	+	+	o		
46B	+	+	+	+	+	+	o
47B	+	+	+	+	+	+	+
48B	+	+	+	+	o		
49B	+	+	+	o			
50B	+	+	+	o			
51B	+	+	+	+	+	+	o
52B	+	+	+	o			
53B	+	+	+	+	o		
54B	+	+	+	+	+	+	+
55B	+	+	+	+	+	+	+

TABLE VI.—*continued.*

Streptococcus.	Immediately after inoculation, present in 1 cc.	2 days later, present in 1 cc.	4 days later, present in 1 cc.	6 days later, present in 1 cc.	8 days later, present in 1 cc.	10 days later, present in 1 cc.	20 days later, present in 1 cc.
56B	+	+	+	+	+	+	+
57B	+	+	+	+	+	+	+
58B	+	+	+	+	+	+	+
59B	+	+	+	+	+	+	+
60B	+	+	+	+	+	+	+
61B	+	+	+	+	+	+	+
62B	+	+	+	+	+	+	+
63B	+	+	+	+	+	+	+
64B	+	+	o				
65B	+	+	+	+	+	+	+
66B	+	+	+	+	+	+	+
67B . .	+	+	+	+	+	+	+
68B	+	+	+	+	+	+	+
69B	+	+	+	+	o		
70B	+	+	+	o			
71B	+	+	+	+	+	+	+
72B	+	+	+	+	+	+	+
73B	+	+	+	+	+	+	+
74B	+	+	+	+	+	+	+
75B	+	+	+	+	+	+	
76B	+	+	+	+	+	+	+
77B	+	+	+	+	+	+	+
78B	+	+	+	+	+	+	+
79B	+	+	+	+	+	+	+
80B	+	+	+	+	+	+	+
81B	+	+	+	+	+	+	+
82B	+	+	+	+	+	+	+
83B	+	+	+	+	+	+	+
84B	+	+	+	+	+	+	+
85B	+	+	+	+	+	+	+
86B	+	+	+	+	+	+	+
87B	+	+	+	+	+	+	+
88B	+	+	+	+	+	+	+
89B	+	+	+	+	+	+	+
90B	+	+	+	+	+	+	+

TABLE VI.—*continued.*

Streptococcus.	Immediately after inoculation, present in ¼ cc.	2 days later, present in 1 cc.	4 days later, present in 1 cc.	6 days later, present in 1 cc.	8 days later, present in 1 cc.	10 days later, present in 1 cc.	20 days later, present in 1 cc.
91B	+	+	+	+	+	+	+
92B	+	+	+	+	+	+	+
93B	+	+	+	+	+	+	+
94B	+	+	+	+	+	+	+
95B	+	+	+	+	+	+	+
96B	+	+	+	+	+	+	+
97B	+	+	+	+	+	+	+
98B	+	+	+	+	+	+	+
99B	+	+	+	+	+	+	+
100B	+	+	+	+	+	+	+

The results were disappointing, inasmuch as 62 per cent. of the 100 streptococci survived for at least 20 days in the salt solution. As regards the remaining 38 streptococci :—

7 per cent. of the 100 streptococci survived 10 days but not 20 days.
4 " " " " " 8 " " 10 "
14 " " " " " 6 " " 8 "
9 " " " " " 4 " " 6 "
4 " " " " " 2 " " 4 "

In brief, not far short of two-thirds of the streptococci were long-lived, less than half died in from 4 to 20 days under the conditions of experiment.

It thus appears that only some fæcal streptococci are to be relied on *qua* their viability to denote recent pollution. When it is remembered that according to the cultural tests employed, the B series of streptococci were divisible into 24 classes or groups this is not surprising. Nevertheless, it is possible that the saline solution employed in these experiments was favourable to the vitality of the streptococci, and that in practice streptococci would die much more speedily than the results of the foregoing experiments would seem to suggest.

As regards the B streptococci, which were tested in tap water as well as in saline solution, it appears that :—

1B, 2B, 71B } survived alike in tap water and saline solution for more than 20 days.

4B was dead in 8 days in the saline solution
25 days in the tap water experiment.

89B survived alike in tap water and saline solution for more than 20 days.

72B lived for at least 20 days in the saline solution, but only 13 days in tap water.

69B died in 7 and 8 days respectively in the tap water and saline solution.

70B died in 6 and 7 days respectively in saline solution and tap water.

It has already been observed that at present there is no proper basis for associating certain ascertained cultural reactions of streptococci with certain observed facts as regards their viability.

F.—*Prospective value of the streptococcus test.*

In conclusion, it is desirable to call attention to certain observed facts which serve to suggest the prospective value of the streptococcus test in public health bacteriology. A convincing demonstration of the actual practical and immediate value of the test is as yet, and owing to incomplete knowledge, another and more difficult matter. The facts in question are :—

(a) *Numerical Abundance.*

In the first place it is important to emphasize the fact that streptococci may be present in human fæces in enormous numbers.

In Series I., out of 100 streptococci 54, 29, 2, and 15 per cent. were isolated respectively from $\frac{1}{100000}$, $\frac{1}{1000000}$, $\frac{1}{10000000}$, $\frac{1}{100000000}$ of a gramme of fæces.

In Series II., 98 per cent. of the 100 streptococci were isolated from $\frac{1}{1000000}$ of a gramme of fæces.

In Series III., of the 100 streptococci 33, 47, and 20 per cent. were isolated from $\frac{1}{100000}$, $\frac{1}{1000000}$, and $\frac{1}{10000000}$ respectively of a gramme of fæces.

(b) *Diversity of Species.*

Secondly, it has been shown that, on the basis of the tests employed, the 300 streptococci were capable of differentiation into no less than 40 groups. It is difficult to believe that all the streptococci comprised in these 40 groups are devoid of practical value as indications of fæcal pollution in the bacterioscopic analysis of water. On the other hand, it needs to be remembered that with 40 groups to select from there is danger of allocating a non-fæcal streptococcus to one or other of the 40 fæcal groups. But this means rather paucity of present knowledge and lack of differential tests than inherent uselessness of the streptococcus test.

(c) *Range of Viability.*

Thirdly, it is not unimportant to possess tests which are capable of detecting both recent and remote fæcal pollution with all the intervening gradations. In this sense the streptococcus test appears to have a special claim to attention; for it has been shown that out of a total of 125 streptococci tested (25 in tap water, 100 in saline solution) as regards viability some perished very rapidly, others less rapidly, others again only very slowly, and some were still alive at the close of the experiment. Nevertheless, it is impossible to say as yet by cultural tests which streptococci will be hardy, and which easily bereft of life. So that at present in practice it would seem to be desirable to resort (in conjunction with the use of the ordinary cultural tests) to actual tests of viability. It is difficult to say what kind of solution should be employed for this purpose. Possibly in the case of water samples a portion of the sample should be set aside for sterilisation purposes. Then if streptococci were isolated from the unsterilised water their vitality might be tested for in the same water after sterilisation. This would enable the observer to classify streptococci (1) according to their biological characters and (2) according to their vitality in the water (after sterilisation) from which they were originally isolated.

DIVISION II.

THE BACTERIOLOGICAL EXAMINATION OF THE I CONTENTS OF CERTAIN SEA-FOWL AND OF FI

This portion of the inquiry proved more arduous tha anticipated, and it is far from being completed. It importance is considerable, as it has a direct bearing on interpretation to be placed on the results of the bac examination not only of drinking waters but of estua and of shell-fish.

The facts ascertained may be considered under three follows:—

SECTION I.

The bacteriological examination of the intestinal co sea-fowl.

SECTION II.

The bacteriological examination of fish of vario dredged from the sea in localities to which, in regard o to pollution, no reasonable objection could be taken.

SECTION III.

Various experiments bearing on the ability of fish with B. coli the water which they are frequenting.

SECTION I.

The bacteriological examination of the intestinal con sea-fowl.

The importance of this investigation may be judged fact that in many estuaries where there are shell-fish gulls are found in large number. In connection wit sources of water supply the possibility of gulls contamin water is, although doubtless a remote contingency, on may on occasion have to be borne in mind. But it is cl relation to shell-fish layings in shallow waters that the of pollution due to the alvine discharges of gulls is of pa importance to the bacteriologist. There are two sides question. On the one hand there are persons of autho regard pollution due to the excreta of birds and th animals, whether healthy or diseased, as of little or portance. According to these authorities, if the tests bacteriologist fail to distinguish between faecal contamin water which is of human origin and that which is due

* Dr. Eyre has recently published an interesting preliminary comm on this subject. In America the subject is attracting a considerable attention.

and the lower animals, the results obtained are of negative value; may, indeed, be most misleading. To cite a concrete instance: In the opinion of these observers, if an estuarial water is polluted with sewage, if gulls are numerous, and if the excreta of gulls and human beings contain apparently similar microbes the results of the *quantitative* bacteriological examination of the water and shell-fish may be of indefinite value because of the total number of excremental micro-organisms found in the water or shell-fish an unknown proportion may have been derived from the evacuations of sea-fowl.

On the other hand there are authorities who consider all kinds of excremental pollution potentially dangerous to health, while admitting that pollution of water caused by the excreta of the lower animals is much less to be feared than contamination arising from a human source. At the same time they would agree that it may be difficult, if not impossible, to distinguish the one contamination from the other.

Limiting discussion to the particular case of the gull, it might be contended that a gull once having eaten food containing numerous B. coli would be apt to harbour this micro-organism in its intestine for an indefinite period, and that B. coli, multiplying in its lower gut, would be voided with every excretion in enormous number. In this view of the case a gull frequenting a pure estuary might, although no longer feeding on filthy food, daily pollute shallow water over an oyster laying; so that the water or the oysters therefrom sent to the bacteriologist might come to be condemned without sufficient warrant.

To this contention the bacteriologist might reply that, even if the foregoing assumptions were found to be correct, there is no surety that the excrement of such a gull is altogether harmless to man, and that to eat oysters containing bacteria derived from even a healthy gull's intestine is possibly to court danger. Further, he might contend that there is the possibility of gulls harbouring in their intestines definitely pathogenic microbes, which they might thus import and sow as it were in situations which on topographical grounds had been approved as practically secure from sewage contamination.

Of course it is possible that an oyster pit approved by the topographist in absence of any drains or sewage discharging in its neighbourhood, might nevertheless have become, the day previous to his visit, polluted to a dangerous extent by some passing tramp suffering from typhoid bacilluria.

Contrariwise a bacteriologist might have sent him, and might condemn, a sample of water from a pure Highland loch, which, by an unhappy chance, included the "droppings" of a passing bird.

Both the topographist and the bacteriologist would in such case be alike the victims of accident. There are, indeed, few problems which can be answered off-hand in an absolute manner; meanwhile reliance is placed on accumulated experience.

So far as my own experience goes of the topographical conditions of estuarial rivers and oyster layings, and of the biologica qualities of the water and oysters, I regard the question o possible contamination due to gull's excreta as a factor whic the bacteriologist cannot reasonably ignore. But the bacteriologis ought to be the first to acknowledge that his results requir interpretation less in an absolute than in a relative sense, and tha all the local conditions should most carefully be considered befor coming to any definite decision. Moreover, as in the future th topographist and bacteriologist must needs work more and mor in unison, there is prospect that the local conditions and the bio logical facts may in time to come be interpreted and harmonise in such a manner as to allow in most cases of a reasonabl estimate as to whether or not there exists in a particular instanc potential danger to health, and, if so, of the degree of it.

It will be convenient to consider the results obtained unde Section I. in the following order:—

The bacterial examination of the excrement of certai sea-fowl (experiments 1 to 10).

Tables showing the biological attributes of the B. coli an streptococci isolated from the gulls' excrement.

Summary of results.

Conclusions.

The bacteriological examination of the excrement of gulls (experiments 1 to 10).

Experiment 1.

Herring gull (A).—A herring gull, shot off the Norfolk coast, was dissected, and the lower gut, when it had been tied at the anal orifice and a few inches higher up, was removed and placed on a sterile plate. The outside of the gut, near its lower end, was seared, and a small opening made with a sterile blade. By means of a suitable sterile instrument 0·5 gramme of the excrement was removed and weighed into a sterile watch glass. This excrement was transferred to a tube containing 9·5 cc. of sterile water and mixed therewith as thoroughly as possible. From this the first tube, further 9 cc. tubes were inoculated by the decimal mode of dilution, each tube receiving 1 cc. from the tube nearest it in the scale of dilution.

B. coli test.—Bile-salt glucose peptone tubes were inoculated with 1 cc. from the various dilutions. All the cultures yielded acid and gas; so secondary plate cultures were made from the last three. B. coli appeared in all the three plates, and the micro-organisms proved to be typical B. coli, as is shown in Table VII. The last plate represented $\frac{1}{2000000000}$ of a gramme of gull's excrement.

B. enteritidis sporogenes test.—Anærobic spore milk cultures were made with 1 cc. from the first four dilutions representing

from $\frac{1}{20}$th to $\frac{1}{2000}$th gramme of excrement. The result, however, was negative.

Streptococcus test.—Surface agar cultures were made with 0·1 cc. from the first four dilutions representing from $\frac{1}{200}$th to $\frac{1}{2000000}$th gramme of excrement.

The first plate was too crowded with colonies for satisfactory examination, and plates three and four showed no minute streptococcus-like colonies. Three colonies were, however, sub-cultured from plate two; but they turned out not to be streptococci.

In this first experiment, therefore, typical B. coli was present in the proportion of 200 million per gramme. But both the streptococcus and B. enteritidis sporogenes tests yielded negative results.

Experiment 2.

Young gull, No. 1 (Norfolk Coast).—The gull was dealt with in like manner to that of the first gull in experiment 1, except that for the primary dilution ·1 gramme was mixed with 9·9 cc. of sterile water.

B. coli test.—Here typical B. coli was isolated from $\frac{1}{100000}$th, $\frac{1}{1000000}$th, and $\frac{1}{10000000}$th of a gramme of excrement (*see* Table VII).

B. enteritidis sporogenes test.—Cultures representing from $\frac{1}{100}$th to $\frac{1}{100000}$th of a gramme of excrement all yielded negative results.

Streptococcus test.—Surface agar cultures representing from $\frac{1}{1000}$th to $\frac{1}{1000000}$th of a gramme of excrement were made but no streptococci were found.

In this experiment, as in the first, typical B. coli was found in great abundance (10 million per gramme); but, as before, the B. enteritidis sporogenes tests yielded negative results.

Experiment 3.

Young gull, No. 2 (Norfolk Coast).—This gull was dealt with in like manner to that of the gull in experiment 2, and precisely similar results were obtained; namely, negative results with the B. enteritidis sporogenes and streptococcus tests, but positive results with the B. coli test (10 million B. coli per gramme, *see* Table VII).

Experiment 4.

Guillemot, No. 1 (Norfolk Coast).—The guillemot was dealt with in like manner to that of the gull in experiment 2, but the results were in the matter of B coli strikingly different.

The B. enteritidis sporogenes ($\frac{1}{100}$th gramme) a
tests ($\frac{1}{1000000}$th gramme) yielded, as before, ne

whereas B. coli which in experiments 1, 2, and 3 with gulls been found to number 200 million, 10 million, and 10 mill respectively per gramme, in experiment 4 B. coli or coli-l microbes of any sort could not be detected in even $\frac{1}{100}$ gram of guillemot excrement.

Experiment 5.

Herring gull (*B*) (Norfolk Coast).—The conditions were same as in experiment 2 except that for the streptococcus Drigalski & Conradi's medium * was used instead of ordin agar.

The B. enteritidis sporogenes test again yielded negative res with $\frac{1}{100}$th gramme.

The streptococcus test did not yield quite negative resu inasmuch as from the $\frac{1}{100000}$th gramme plate three streptoc (albeit of aberrant type) were isolated. Their biological charac are given in Table VIII.

As regards the B. coli test, typical B. coli were isolated fr $\frac{1}{10000000}$th, $\frac{1}{100000000}$th, and $\frac{1}{1000000000}$th of a gramme excrement (*see* Table VII).

Experiment 6.

Herring gull (*C.*) (Norfolk Coast).—This gull was dealt w as in the previous experiment.

The B. enteritidis sporogenes test again yielded a negati result with $\frac{1}{100}$th gramme.

As regards the streptococcus test, five streptococci were isolat from $\frac{1}{100000}$th of a gramme. It is noteworthy that all fi of these streptococci yielded positive results with the neut red broth, litmus milk, inulin, saccharose, lactose, mannite, a raffinose tests. Not one of 300 streptococci isolated fr normal human fæces gave a positive result with each of the tests severally.

The B. coli test yielded remarkable results, inasmuch although typical B. coli was isolated from $\frac{1}{10000000000}$th of gramme, coli-like microbes producing alkali were isolated fro $\frac{1}{100000000000}$th and $\frac{1}{1000000000000}$th of a gramme. In other wor alkali producing coli-like microbes were actually more numero than the typical acid producing B. coli (*see* Table VII).

Experiment 7.

Lesser black backed gull (Norfolk Coast).—This gull was de with as in the previous experiment.

The B. enteritidis sporogenes and streptococcus tests yield negative results, with $\frac{1}{100}$th and with $\frac{1}{100000}$th of a gramme.

* It is worth noting that when using Drigalski & Conradi's medium t number of "blue" colonies in the plates is far greater with the excrement gulls than has been found to be the case as regards normal human fæces.

Typical B. coli were isolated from $\frac{1}{10000000}$th, $\frac{1}{100000000}$th, and $\frac{1}{1000000000}$th of a gramme (*see* Table VII).

Experiment 8.

Guillemot No. II. (Norfolk Coast).—This guillemot was dealt with as in the previous experiment.

B. enteritidis sporogenes test $\frac{1}{100}$th gramme.
Streptococcus test $\frac{1}{100000}$th gramme.
B. coli test $\frac{1}{100}$th gramme.
} As in experiment 4 the results were wholly negative.

Experiment 9.

Adult Herring gull (*D.*) (Norfolk Coast).—In this experiment the B. coli and streptococcus tests were not applied. (*a*) The lower gut having been ligatured and removed as in experiment 1, was well washed with sterile water and finally placed inside a large milk tube. With a suitable sterile instrument the wall of the gut was punctured in a number of places so as to allow its contents to exude, and was then, after being heated to 80° C. for ten minutes, cultivated anærobically.

(*b*) The whole of the rest of the intestine was ligatured, removed, and treated as in (*a*), the only difference being that a specially large milk tube was employed.

Both (*a*) and (*b*) tubes developed the typical "enteritidis" change. 1 cc. of (*a*) culture was inoculated subcutaneously into each of two guinea-pigs. The cultures proved non-virulent.

Experiment 10.

Immature Herring gull (*E.*) (Norfolk Coast).—The gull was dealt with as in experiment 2.

As regards the B. enteritidis sporogenes test beside $\frac{1}{100}$th to $\frac{1}{1000000}$th gramme cultures, an additional culture was made with as much as 0·37 gramme of excrement. Both this culture and the $\frac{1}{100}$th gramme culture gave positive results; that from the 0·37 gramme of excrement proved virulent.

The streptococcus test also yielded positive results, streptococci being isolated from $\frac{1}{10000000}$th and $\frac{1}{100000000}$ of a gramme of excrement. Their attributes are shewn in Table VIII. Streptococci 13, 14, and 16 did not seem to fall under any one of the 40 groups described in Division I. of this report. But streptococci 9, 10, 11, 12, and 15 appeared to come under groups, xxvii., xxxvi., vi., i., and iv., respectively.

B. coli was isolated from $\frac{1}{100000000}$ up to $\frac{1}{1000000000}$th of a gramme (*see* Table VII).

It will be noted that alkali producing coli-like microbes as well as typical B. coli were isolated from a fractional amount of the material.

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Tables showing the biological attributes of the B. coli and streptococci isolated from the gull's excrement.

TABLE VII.

Showing the biological character of the B. coli or coli-like microbes isolated from the gull's excrement.

Number.	Gelatine "shake" cultures (+ = gas formation); 24 hours at 20° C.	Neutral red broth cultures (Fl = greenish yellow fluorescence); 2 days at 37° C.	Lactose peptone cultures (Ag. = acid and gas); 2 days at 37° C.	Broth cultures for indol (In. = indol); 5 days at 37° C.	Litmus milk cultures (Ac = acid and clot); 5 days at 37° C.	Remarks.
1	+	Fl.	Ag.	In.	Ac	Isolated from $\frac{1}{[illegible]}$ of a gramme of excrement. (Experiment 1.)
2	+	"	"	"	"	Isolated from $\frac{1}{[illegible]}$ of a gramme of excrement. (Experiment 1.)
3	+	"	"	"	"	Isolated from $\frac{1}{[illegible]}$ of a gramme excrement. (Experiment 1.)
4	+	"	"	"	"	Microbes 4, 5, and 6 were isolated respectively from $\frac{1}{[illegible]}$, $\frac{1}{[illegible]}$, and $\frac{1}{[illegible]}$ of a gramme of excrement. (Experiment 2.)
5	+	"	"	"	"	
6	+	"	"	"	"	
7	+	"	"	"	"	Microbes 7, 8, and 9 were isolated respectively from $\frac{1}{[illegible]}$, $\frac{1}{[illegible]}$, and $\frac{1}{[illegible]}$ of a gramme of excrement. (Experiment 3.)
8	+	"	"	"	"	
9	+	"	"	"	"	
No B. coli or coli-like microbes of any sort were present in $\frac{1}{100}$ gramme. (Experiment 4.)						
10	+	Fl.	Ag.	In.	Ac	Microbes 10, 11 and 12 were isolated respectively from $\frac{1}{[illegible]}$, $\frac{1}{[illegible]}$, and $\frac{1}{[illegible]}$ of a gramme of excrement. (Experiment 5.)
11	+	"	"	"	"	
12	+	"	"	"	"	
13	+	"	"	"	"	Microbes 13, 14, and 15 were isolated respectively from $\frac{1}{[illegible]}$, $\frac{1}{[illegible]}$ and $\frac{1}{[illegible]}$ of a gramme of excrement. (Experiment 6.)
14	+	"	Neg.	"	Alkali	
15	+	"	"	"	"	
16	+	"	Ag.	"	Ac.	Microbes 16, 17, and 18 were isolated respectively from $\frac{1}{[illegible]}$, $\frac{1}{[illegible]}$, and $\frac{1}{[illegible]}$ of a gramme of excrement. (Experiment 7.)
17	+	"	"	"	"	
18	+	"	"	"	"	
No B. coli or coli-like microbes of any sort were present in $\frac{1}{100}$ gramme. (Experiment 8.) In Experiment 9 no tests for B. coli were applied.						
19	+	Fl.	Neg.	In.	Alkali	Microbes 19, 20, 21, 22 were isolated from $\frac{1}{[illegible]}$, of a gramme of excrement. (Experiment 10.)
20	+	"	"	"	"	
21	+	"	Ag.	"	Ac	Microbes 23, 24, and 25 were isolated respectively from $\frac{1}{[illegible]}$, $\frac{1}{[illegible]}$ and $\frac{1}{[illegible]}$ of a gramme of excrement. (Experiment 10.)
22	+	"	"	"	"	
23	+	"	"	"	"	
24	+	"	"	"	"	N.B.—None of these 25 microbes liquefied gelatine.
25	+	"	"	"	"	

TABLE VIII.

Showing the biological attributes of the streptococci (or *query* streptococci) isolated from the gull's excrement.

Fractions of a gramme.	Experiment.	Number.	Morphology.	Broth cultures.	Gelatine streak cultures.	Salicin (+ = acid change); 2 days at 37° C.	Saccharose (+ = acid change); 2 days at 37° C.	Lactose (+ = acid change); 2 days at 37° C.	Neutral red, anaerobic (+ = fluorescence); 2 days at 37° C.	Mannite (+ = acid change); 2 days at 37° C.	Litmus milk (+ = acid and clot); 5 days at 37° C.	Raffinose (+ = acid change); 2 days at 37° C.	Inulin (+ = acid change); 2 days at 37° C.	Nitrate broth (+ = nitrite); 2 days at 37° C.
[illegible]	5	1	Short chains of cocci.	Diffuse cloudiness.	Minute colonies, but eventually liquefied the gelatine.	No record.	+	+	+	+	Peptonisation.	-	-	No record.
	"	2					+	+	+	+		-	-	
	"	3					+	+	+	+		-	-	
	6	4	Short chains of cocci.	Diffuse cloudiness.	Minute strepto-coccus-like colonies.	No record.	+	+	+	+	+	+	+	No record.
	"	5					+	+	+	+	+	+	+	
	"	6					+	+	+	+	+	+	+	
	"	7					+	+	+	+	+	+	+	
	"	8					+	+	+	+	+	+	+	
[illegible]	10	9	Short chains of cocci.	Diffuse cloudiness.	Minute transparent strepto-coccus-like colonies.	+	-	+	-	+	+	-	-	-
	"	10				+	+	+	+	+	+	+	-	-
	"	11				+	-	+	-	-	+	-	-	-
[illegible]	"	12				+	+	+	+	+	+	-	-	-
	"	13				-	-	-	+	-	-	-	-	-
	"	14				+	+	+	+	+	+	-	+	-
	"	15				+	+	+	-	-	+	-	-	-
	"	16				+	+	+	+	+	+	-	-	-

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Summary of results: Section 1.

The foregoing results may be summarised as follows:—

Number of experiment and description of gull.	Number of "flagino" B. coli per gramme of excrement.	Streptococcus test.	B. enteritidis sporogenes test.	Remarks
Experiment 1 .. Herring gull A.	200,000,000*	Negative result, plates representing from $\frac{1}{20}$ to $\frac{1}{2000}$ gramme.	Negative result, cultures representing $\frac{1}{20}$ to $\frac{1}{200}$ gramme.	*Owing to the great difficulty of thoroughly mixing the gull's excrement with the drinking water, it is probable that the figures for B. coli are too high.
Experiment 2 .. Young gull No. 1.	10,000,000	Negative result, plates representing from $\frac{1}{20}$ to $\frac{1}{2000}$ gramme.	Negative result, cultures representing $\frac{1}{20}$ to $\frac{1}{200}$ gramme.	—
Experiment 3 .. Young gull No. 2.	10,000,000	"	"	—
Experiment 4 .. Guillemot I.	No B. coli or coli-like microbes in $\frac{1}{10}$ gramme.	Negative result plates representing from $\frac{1}{100}$ to $\frac{1}{1000}$ gramme.	"	—
Experiment 5 .. Herring gull B.	1,000,000,000	Liquefying streptococci (?) isolated from $\frac{1}{100}$ gramme.	"	—
Experiment 6 .. Herring gull C	1,000,000,000 (also alkali-forming microbes).	Streptococci isolated from $\frac{1}{100}$ gramme.	"	The number of alkali-producing coli-like microbes in the excrement was remarkable.
Experiment 7 .. Lesser black backed gull.	100,000,000	Negative result, plates representing from $\frac{1}{1000}$ to $\frac{1}{10000}$ gramme.	"	—
Experiment 8 .. Guillemot II.	Negative results as in Experiment 4.			—
Experiment 9 .. Adult Herring gull D	No record	No record ..	Positive result.	Here a positive result as regards the B. enteritidis sporogenes test was obtained by inoculating the culture tubes with the excrement in bulk. The culture, however that was tested for pathogenicity proved to be non-virulent.
Experiment 10 .. Immature Herring gull E.	100,000,000,000 (also alkali forming microbes).	Streptococci isolated from plates representing $\frac{1}{1000}$ to $\frac{1}{10000}$ of a gramme.	Positive result in '01 and '37 gramme cultures.	The '37 gramme B. enteritidis sporogenes culture proved virulent. The number of alkali-producing coli-like microbes was noteworthy

Conclusions: Section I.

It is to be noted that all the gulls contained typical B. coli in their excrement in enormous numbers and that the guillemots did not contain B. coli of any sort. The latter yielded negative results also, under the conditions of the experiments with the B. enteritidis sporogenes and the streptococcus tests. This result doubtless is to be properly ascribed to the different habits as regards food of these different species of sea-birds. As the ordinary gulls are prone to feed on garbage and filth of various kinds, whereas the guillemots are, it is believed, clean feeders, it must not too hastily be concluded that the results as regards the presence of B. coli in the gulls seriously discount the value of bacterioscopic analyses of estuarial waters and shell-fish. If gulls feed on substances which are liable to contain objectionable bacteria, it is perhaps not altogether to be regretted that they reflect, even magnify possibly, in the bacterial flora of their intestines the filthy source of their food. At the same time it is only fair to add that any danger to water or to shell-fish accruing from the ingestion of objectionable bacteria by the gulls may easily be exaggerated for the reason that B. coli in all probability multiplies in their alimentary tract to an enormous extent. When gulls are very numerous and the contamination of an estuary with sewage is slight the results of the bacteriological examination of the water and shell-fish thence obtained might easily lead to an over-estimate of the potential danger to health; for the reason that of the total number of B. coli found in these materials only an inconsiderable proportion might have been derived from the sewage—the majority being of gull origin. Gulls, however, are apt to congregate where filth is discharged into the estuary and to follow in the wake of such filth (*e.g.* sewage), so that, generally speaking, their presence merely means that additional B. coli are being added to water which already contains B. coli derived from more objectionable sources. Nevertheless, as it is admitted that the excrement of gulls is much less likely to be harmful than human alvine discharges, not all the B. coli found in waters polluted alike by gulls and sewage are of the same significance. The more numerous the gulls in relation to the amount of sewage pollution the less significant become the numerical results of the bacteriologist, as regards the B. coli test.

The earlier experiments in this series seemed to afford grounds for anticipating that both streptococci and the spores of B. enteritidis sporogenes were habitually absent from gulls' excrements. But the later experiments appeared to indicate that it is a question of degree only. Nevertheless, it was certainly more difficult to obtain positive results with these tests with the excrement of gulls than when dealing with human fæces. On the whole, I think it will turn out that B. coli is apt to be more and streptococci and the spores of B. enteritidis sporogenes relatively less numerous in the gull than in man.

As regards the biological attributes of the B. coli and streptococci isolated from the gulls, the B. coli of the gull seemed to be indistinguishable from the B. coli of the human intestine. But accompanying the typical B. coli in the gull were large numbers

of alkali-producing coli-like microbes which in default of the application of proper tests might have been confused with Gärtner's bacillus. These bacilli gaining access to shell-fish might possibly, in the absence of careful work, be mistaken for the aërobic B. enteritidis. As regards the streptococci, some were of an aberrant type, but others, on the basis of the tests employed, seemed to be identical with certain streptococci isolated from human fæces.

Although it would seem likely from the guillemot experiments that B. coli is not a necessary inhabitant of the intestine of gulls generally, it may be the case that the gull of our coasts, like the human subject, is so circumstanced that B. coli, although not essential, is unavoidably parasitic in its lower gut.

Section II.

*The bacteriological examination of fish of various kinds dredged from the sea in localities to which, on topographical considerations, no reasonable objection could be taken on the score of pollution.**

It has been suggested that sea fish frequenting the neighbourhood of shell-fish layings might so alter the biological qualities of the water around and in the interior of shell-fish as to render the tests of the bacteriologist of doubtful value. This suggestion is based probably on the assumption that fish normally contain B. coli in their intestines, or that once ingested with their food it becomes parisitic in their lower gut and is voided with their excrement in large number. Although the excrement of cold-blooded fish might on *a priori* grounds be considered less objectionable than that of warm-blooded birds and animals, illness and disease in human beings has been so frequently ascribed to the consumption of raw or imperfectly cleaned and partially-cooked fish that the bacteriology of their intestines becomes the more interesting.

It will be convenient to consider the results obtained under Section II. in the following order :—

First consignments of fish from the Norfolk coast (experiments 1 to 20).

Second consignments of fish from the Norfolk coast (experiments 21 to 38).

Table showing the biological attributes of the B. coli or coli-like microbes isolated from the fish in question.

Summary of results.

Conclusions.

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* I am greatly indebted to Mr. Donnison, Chief Inspector Eastern Sea Fisheries District, for his kindness in sending me from time to time fish for experimental purposes

*First consignment of fish taken 1½ miles from land abreast of Saltfleet (Lindsay). Tide ¾ ebb, depth of water 4 to 5 fathoms. Norfolk coast.**

Experiments 1, 2, 3, 4, 5.

Five shrimps (*a*, *b*, *c*, *d*, *e*) were severally washed thoroughly with tap water and then with sterile water. Each shrimp was next cut up with a sterile pair of scissors and transferred to a large, 50 cc., bile-salt glucose peptone tube. These cultures (*a*, *b*, *c*, *d*, *e*) were incubated at 37° C., and all developed acid and gas. Accordingly plate cultures were made from these cultures and the B. coli or coli-like microbes isolated from them studied in detail. The results are shewn in Table IX; but here it may be noted that not one of the subcultures yielded typical B. coli.

Experiments 6, 7, 8.

Three whelks (*a*, *b*, *c*) were washed, as regards their shells, and then treated as follows:—

In all the experiments the whelks were broken up as completely as possible within their shell by means of suitable sterile instruments. In experiment 6 the whelk was removed bit by bit and transferred to a 50 cc. bile-salt glucose peptone tube. In experiments 7 and 8, 1 cc. of the mixed liquor and body juices of the whelk were severally added to 10 cc. bile-salt glucose peptone tubes. In all three cultures acid and gas developed; so that plate cultures were made from them, for the isolation and study of B. coli or coli-like microbes in detail (*see* Table IX). Here, as in experiments 1 to 5, no typical B. coli were found.

Experiment 9.

A large crab was washed first with tap then with sterile water. The ventral surface was next removed and the organs of the body mashed up in the shell. Then 1 cc. of the mixture was added to a 10 cc. bile-salt glucose peptone tube. An acid change occurred in the culture with some gas formation. But no coli-like microbe of any sort could be isolated.

Experiment 10.

A small gurnet was washed first with tap then with sterile water. The *whole fish*† was cut up with sterile scissors and transferred to a large, 50 cc., bile-salt glucose peptone tube.

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* The water in this locality could not reasonably be objected to on topographical considerations.

† It will not, I trust, be forgotten that the experiments were [illegible] contrived to refute, if possible, my own personal belief in [illegible] of the B. coli test.

Experiment 11.

A small cat-fish was similarly treated.

Experiment 12.

A hermit-crab was removed carefully from its shell and similarly dealt with.

All three cultures (experiments 10, 11, and 12) developed acid and gas, and in each case a coli-like microbe was isolated (*see* Table IX). But none of these coli-like microbes were found to be typical B. coli.

Experiment 13.

A small whiting was treated in the same way as in experiments 10, 11, and 12: but the result was different, inasmuch as a microbe was isolated which proved, on the basis of the tests employed, to be indistinguishable from typical B. coli (*see* Table IX).

Experiments 14, 15, 16, 17.

In these experiments two soles (experiments 14 and 15), a plaice (experiment 16), and a dab (experiment 17) were treated as follows:—The fish were washed, seared in the neighbourhood of the anal aperture, and, by means of a suitable pipette, approximately $\frac{1}{10}$ cc., $\frac{1}{100}$ cc., $\frac{1}{1000}$ cc., and $\frac{1}{10000}$ cc. of the intestinal contents were withdrawn from the gut and added to 10 cc. bile-salt glucose peptone tubes. The result of such culture was negative in all four cases.

Experiment 18 (*A. B.*).

A.—A brill, after having been washed, was seared in the neighbourhood of the anal aperture, and $\frac{1}{10}$ cc. of its intestinal contents, withdrawn from the gut by means of a suitable pipette, was added to a test tube containing 9·9 cc. of sterile water. From this tube other tubes were inoculated by the decimal mode of dilution. Bile-salt glucose tubes were inoculated from the various dilutions. The result was negative.

B.—This fish was then carefully dissected; the intestine, after having been ligatured at both ends, was removed, washed first in tap then in sterile water, cut up with sterile instruments, and transferred to a 50 cc. bile-salt glucose peptone tube. With the aid of a strong sterile wire the contents of the gut were incorporated as far as this was possible with the medium, after which 1 cc. was withdrawn and used to make a decimal series of dilutions. From each of these dilutions a 10 cc. bile-salt glucose peptone tube was inoculated. All of the dilution cultures yielded

negative results, and, although the original 50 cc. tube developed acid and gas, secondary gelatine plate cultures from it revealed the presence only of liquefying microbes.

Experiments 19 *and* 20.

In these experiments bile-salt glucose peptone tubes were inoculated with $\frac{1}{100}$ and $\frac{1}{1000}$ cc. of the intestinal contents of two skates. The results were negative.

Second consignment of fish from same source. One hour after high water, 2 *p.m.*

Experiment 21 (*A. B.*).

A.—A brill was washed, seared in the neighbourhood of the anal aperture, and 0·1 cc. of its intestinal contents, withdrawn by means of a suitable pipette, added to a 10 cc. bile-salt glucose peptone tube.

B.—The lower gut was next exposed by dissection, cut into with sterile instruments, and 1 cc. of the contents added to 9 cc. of sterile water (dilution 1); 1 cc. of dilution 1 was added to a second 9 cc. tube (dilution 2); 1 cc. of dilution 2 to a third tube (3); and so on up to a fifth dilution. 1 cc. from the several dilutions was added in each instance to a bile-salt glucose peptone tube.

Both as regards A. and B. the results were negative.

Experiments 22 *to* 30.

In these experiments the fish were washed first in tap then in sterile water. They were next cut into small pieces with sterile instruments and transferred severally to 50 cc. bile-salt glucose peptone tubes. The species of fish were as follows:—

Experiment	22.	Small cat-fish	From all of these cultures B. coli or coli-like microbes were isolated (*see* Table IX). None of them were completely typical except B. coli Nos. 19 and 20, but B. coli No. 19 differed from Escherich's B. coli inasmuch as it fermented cane-sugar.*
„	23.	„ „	
„	24.	Shrimp	
„	25.	Gurnet	
„	26.	„	
„	27.	Small crab	
„	28.	„ „	
„	29.	Hermit crab	
„	30.	„ „	

* Escherich's B. coli does not ferment cane-sugar.

Experiment 31.

A dog-fish was dissected, and the whole of the intestine was removed after applying a double ligature. The intestine was washed first in tap and then in sterile water, and then transferred to a 50 cc. bile-salt glucose peptone tube. A suitable instrument was next used to break up the intestinal wall, so as to mix the intestinal contents with the nutrient medium. After this had been done further bile-salt glucose peptone tubes were inoculated with 10 cc., 1 cc., and $\frac{1}{10}$ cc. of the mixture. With the exception of the $\frac{1}{10}$ cc. tube all the cultures developed acid and gas. But no coli-like microbes could be isolated from any except the 1 cc. culture, and this turned out to be a liquefier.

Experiment 32.

The shells of two whelks were washed first with tap water and finally with sterile water. The whelks were next placed in a sterile beaker and enough sterile glucose peptone medium poured into the beaker to more than cover them. A sterile plate was next placed over the beaker and the culture incubated at 37°. There was a development of acid and gas, but the secondary plate cultures failed to show the presence of any coli-like microbes.

Experiment 33.

The intestines of a skate were exposed by dissection, cut up with a sterile instrument and loop cultures made into five bile-salt glucose peptone tubes.

Experiment 34.

The experiment was repeated with a second skate.

In both experiments (10 cultures altogether) the results were negative.

Experiments 35 *to* 38.

In these experiments the fish were cut obliquely with a strong pair of sterile scissors in such a way as to exclude the head and fleshy portion but include all the internal organs and alimentary tract. This latter portion (organs and guts) was washed first with tap then with sterile water, cut up, and transferred to a 50 cc. bile-salt glucose peptone tube. The species of fish were as follows:—

Experiment	35.	Dab	From all these cultures (except experiment 36) B. coli or coli-like microbes were isolated (see Table IX). Nos. 23 and 24 were typical B. coli. No. 25 failed as regards the indol test.
,,	36.	Sole	
,,	37.	Sole	
,,	38.	Sole	

TABLE IX.

Showing the Biological attributes of the B. coli or coli-like Microbes isolated from the fish.

Number.	Gelatine "shake" cultures (+ = gas formation); 24 hours at 20° C.	Neutral red broth cultures (fl. = greenish yellow fluorescence); 2 days at 37° C.	Lactose peptone cultures (A.G. = acid and gas); 2 days at 37° C.	Broth cultures for indol (in. = indol); 5 days at 37° C.	Litmus milk cultures (A.C. = acid and clot); 5 days at 37° C.	Cane sugar peptone cultures (A.G. = acid and gas); 2 days at 37° C.	Remarks.			
1	+	½+	Acid, no gas.	–	Sl. acid, no clot.	–	Shrimp	(a).	Expt. 1	No liquefaction of gelatine; 1 month.
2	+	+	Acid, sl. gas.	–	Acid, no clot.	A.G.	„	(b).	„ 2	
3	+	–	–	–	Sl. acid, no clot.	Acid, no gas.	„	(c).	„ 3	
4	+	–	–	–	Sl. acid, no clot.	Acid? sl. gas.	„	(d).	„ 4	
5	+	½+	–	–	Sl. acid, no clot.	–	„	(e).	„ 5	
6	+	–	–	–	Sl. acid, no clot.	Acid, no gas.	Whelk	(a).	„ 6	
7	+	–	–	–	Acid, no clot.	Acid, no gas.	„	(b).	„ 7	
8	+	+	Bleached, one bubble gas.	–	Acid, no clot.	Bleached and gas.	„	(c).	„ 8.	Slow liquefier.
9	+	–	–	–	Acid, no clot.	Acid, no gas.	Gurnet.		„ 10	No liquefaction of gelatine; 1 month.
10	+	½+	–	–	Sl. acid, no clot.	–	Cat-fish.		„ 11	
11	+	–	–	–	Sl. acid, no clot.	–	Hermit-crab.		„ 12	
12	+	+	A.G.	+	A.C.	–	Whiting.		„ 13.	No liquefaction of gelatine
13	+	–	Acid, no gas.	–	Acid, no clot.	Acid, sl. gas.	Cat-fish.		„ 22	No liquefaction of gelatine; 1 month.
14	+	+	Acid, no gas.	–	A.C.	–	„		„ 23	
15	+	½+	A.G.	–	A.C.	–	Shrimp.		„ 24	
16	+	–	–	–	Negative	Acid and gas.	Gurnet.		„ 25	
17	+	+	A.G.	–	Acid, no clot.	Acid and gas.	„		„ 26	
18	+	–	A.G.	+	Acid and clot.	Acid, and gas.	Small crab.		„ 27	
19	+	+	A.G.	+	Acid and clot.	Acid and gas.	„	„	„ 8	
20	+	+	A.G.	+	A.C.	–	Hermit-crab.		„ 29	
21	+	–	A.G.	–	Acid, no clot.	Acid and gas.	„	„	„ 30	
22	+	–	Acid, no gas.	–	Peptonisation.	Acid, no gas.	Dog-fish		„ 31	Liquefier.
23	+	½+	A.G.	+	A.C.	–	Dab.		„ 35	
24	+	+	A.G.	+	A.C.	–	Sole.		„ 37	
25	+	½+	A.G.	–	A.C.	–	„		„ 38	

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Summary of Results: Section II.

It is difficult to bring into line the foregoing results for the reason that the conditions of experiment varied greatly. This summary therefore needs to be read in thelight of the preceding detailed description. As the cane-sugar test involves points open to dispute it will not be considered here; a microbe will be spoken of as typical B coli if it forms indol in broth cultures, fluorescence in neutral red broth cultures, both acid and gas in lactose peptone cultures, and both acid and clot in litmus milk cultures. All other varieties of B. coli will be called atypical coli-like microbes.

Expt.	Species of fish.	Results as regards presence or absence of B coli.	Expt.	Species of fish.	Results as regards presence or absence of B. coli.
1	Shrimp ..	Atypical coli-like microbes.	20	Skate.. ..	Negative result.
2	" ..	" " "	21	Brill	" "
3	" ..	" " "	22	Cat-fish	Atypical coli-like microbes.
4	" ..	" " "	23	" ..	" " "
5	" ..	" " "	24	Shrimp ..	" " "
6	Whelk ..	" " "	25	Gurnet ..	" " "
7	" ..	" " "	26	" ..	" " "
8	" ..	" " "	27	Crab	" " "
9	Crab	Negative result.	28	"	Typical B. coli.
10	Gurnet ..	Atypical coli-like microbes.	29	Hermit-crab	" "
11	Cat-fish ..	" " "	30	"	Atypical coli-like microbes.
12	Hermit-crab	" " "	31	Dog-fish ..	" " "
13	Whiting ..	Typical B. coli.	32	Whelk ..	Negative result.
14	Sole	Negative result.	33	Skate . ..	"
15	"	" "	34	" . .	" "
16	Plaice ..	" "	35	Dab	Typical B. coli.
17	Dab	" "	36	Sole .. .	Negative result
18	Brul	" "	37	" .. .	Typical B. coli.
19	Skate . ..	" "	38	" .. .	Atypical coli-like microbes.

Conclusions: Section II.

It is to be noted that in 34 per cent. of these fish experiments the results were negative. In 52 per cent. of the experiments the microbes were atypical. In 13 per cent. of the cases typical B. coli, on the basis of the tests employed, were isolated from the fish. *In the latter instances, either the whole fish or the whole of the alimentary tract had been added to the nutrient medium.**

* In experiments of this kind it is difficult to be absolutely certain that no microbes adhering to the outside of the fish were introduced into the nutrient medium.

Although these results show that fish dredged from a source seemingly above all suspicion of objectionable contamination, may contain sometimes apparently typical B. coli in their interior, it is obvious that in the great majority of cases the results were either wholly negative or the microbes that were isolated proved to be atypical in character.

A common-sense interpretation of the results would seem to be that typical B. coli is either absent or present in small number in the intestines of fish dredged from the sea in localities remote from sewage pollution. Further, as 34 per cent. of the experiments were wholly negative, it can hardly be the case that even coli-*like* microbes are present naturally in abundance in fish.

These results are in general agreement with those set forth in my report to the Royal Commission on Sewage Disposal.* In that report it was stated that "Judging these experiments as a whole, the conclusion seems inevitable that in oysters derived from deep-sea water remote from sewage pollution B. coli and coli-like microbes, as also the spores of B. enteritidis sporogenes, are either absent or, at all events, seldom detectable. The same was found true of the surface water over such oysters."

The grounds for this statement were as follows :—

Thirty-four samples of unpolluted sea water obtained from the West Coast of Scotland contained no coli-like microbes of any sort in 100 cc. of sample.

Eight samples of sea water obtained from off the Norfolk coast at a point far removed from pollution yielded results as follows :—In six out of the eight experiments as much as 1,000 cc. of the water were submitted to cultural test. The result was negative in four out of the six samples, and in the remaining two samples no typical B. coli could be found. Only one out of the eight samples contained coli-like microbes, but no typical B. coli were discovered in it when using 100 cc. for cultural purposes.

As regards the deep-sea oysters, it may be said that although sometimes coli-like microbes were found in the individual oyster in no instance (save perhaps, one) was typical B. coli isolated. The results may be tabulated as follows :—

	Amount of oyster liquor or mixed liquor and juices of oyster tested.	Results, as regards	
		Atypical coli-like microbes.	Typical B. coli.
Experiment I. Oyster A	cc. 1	Positive	Negative
„ „ B	2	„	„
„ „ C	2	„	„
„ „ D	2	„	„
„ „ E	2	„	„
„ „ F	2	„	„
„ „ G	4	„	„

* Fourth Report, Vol. III.

App. B, No. 7.

Report on Bacteriological Examination of (1) Excreta of Man; (2) Excreta of Sea-fowl and Fish, and (3) certain Potable Waters; by Dr. Houston.

—			Amount of oyster liquor or mixed liquor and juices of oyster tested.	Results, as regards	
				Atypical coli-like microbes.	Typical B. coli.
			cc.		
Experiment	I.	Oyster H	5	Negative	Negative.
"	"	" I	5	Positive	"
"	"	" J	5	"	"
Experiment	II.	Oyster A	10	Negative	"
"	"	" B	10	"	"
"	"	" C	7	"	"
"	"	" D	1	"	"
"	"	" E	1	"	"
"	"	" F	10	"	"
"	"	" G	9	"	"
"	"	" H	1	"	"
"	"	" I	2	"	"
"	"	" J	1	"	"
Experiment	III.	Oyster A	4	"	"
"	"	" B	6	"	"
"	"	" C	2	"	"
"	"	" D	10	"	"
"	"	" E	1	"	"
"	"	" F ..	4	"	"
"	"	" G	10	"	"
"	"	" H	7	"	"
"	"	" I	10	"	"
"	"	" J .. .	5	"	"
Experiment	IV.	Oyster A .. .	10	"	"
"	"	" B .. .	"	"	"
"	"	" C	"	"	"
"	"	" D	"	"	"
Experiment	V.	Oyster A	"	"	"
"	"	" B	"	"	"
Experiment	VI.	Oyster A .. .	1	"	"
"	"	" "	2	"	"
"	"	" " .. .	8	Positive	"
"	"	" B .. .	1	"	"
"	"	" "	2	Negative	"
"	"	" "	3	Positive	"
"	"	" C	1	Negative	"
"	"	" "	2	"	"
"	"	" "	3	"	"
"	"	" D	1	"	"

—	Amount of oyster liquor or mixed liquor and juices of oyster tested.	Results, as regards	
		Atypical coli-like microbes.	Typical B. coli.
	c.c.		
Experiment VI. Oyster D	2	Negative.	Negative.
" " "	9	"	"
" " E	1	"	"
" " " . ..	2	"	"
" " "	5	"	"
Experiment VII. Oyster A	1	"	"
" " "	2	"	"
" " "	8	"	"
" " B	1	"	"
" " "	2	"	"
" " "	3	"	"
" " C	1	"	"
" " "	2	"	"
" " "	3	"	"
" " D	1	"	"
" " "	2	"	"
" " "	6	"	"
" " E	10	Positive	Nearly, but not quite typical.
Experiment VIII. Oyster A	1	Negative	Negative
" " "	2	"	"
" " "	3	"	"
" " B	1	"	"
" " "	2	"	"
" " "	3	Positive	"
" " C	1	Negative	"
" " "	2	"	"
" " "	5	"	"
" " D	1	"	"
" " "	2	"	"
" " "	8	"	"
" " E	1	"	"
" " "	2	"	"
" " "	3	"	"
Experiment IX. Oyster A	1	"	"
" " "	1	"	"
" " "	2	"	"
" " B	1	"	"
" " "	2	"	"
" " C	1	"	"

—					Amount of oyster liquor or mixed liquor and juices of oyster tested.	Results, as regards	
						Atypical coli-like microbes.	Typical B. coli.
					c.c.		
Experiment	IX.	Oyster	C	.. ..	2	Negative.	Negative.
"	"	"	"	.. ..	30	"	"
"	"	"	D	.. ..	1	"	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	15	"	"
"	"	"	E	.. ..	1	"	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	16	"	"
Experiment	X.	Oyster	A	.. ..	1	"	"
"	"	"	B	.. ..	1	"	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	3	"	"
"	"	"	C	.. ..	1	Positive	"
"	"	"	"	.. ..	2	Negative	"
"	"	"	"	.. ..	4	"	"
"	"	"	D	.. ..	1	"	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	6	"	"
"	"	"	E	.. ..	1	"	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	5	"	"
Experiment	XI.	Oyster	A	.. ..	1	"	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	0	"	"
"	"	"	B	.. ..	1	"	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	5	"	"
"	"	"	C	.. ..	1	"	"
"	"	"	"	.. ..	2	Positive	"
"	"	"	D	.. ..	1	Negative	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	5	"	"
"	"	"	E	.. ..	1	"	"
"	"	"	"	.. ..	2	"	"
"	"	"	"	.. ..	5	"	"
Total { 11 series of experiments, 66 oysters.					Total of 382 c.c. added to 120 culture tubes (over 4 c.c., on the average, per culture tube).	120 cultures yielding 16 (about 13 per cent.) positive, and 104 (about 86 per cent.) negative results.	120 cultures yielding no (? one) positive results, and 120 (? 119) negative results.

It will be seen from the foregoing table that 120 cultures were made from 66 deep sea oysters; that a total of 382 cc. of oyster liquor were submitted to cultivation (over 4 cc. per oyster on the average); that of the 120 cultures 16 (about 13 per cent.) yielded positive, and 104 (about 86 per cent.) yielded negative results as regards the presence of coli-like microbes; and that with possibly a single exception none of the cultures were found to contain typical B. coli.

The hypothesis, therefore, that the excreta of fish may pollute oysters with B. coli in regions remote from objectionable contamination gets no support from the results of the present investigation nor from the inquiry carried out on behalf of the Royal Commission on Sewage Disposal.

Fish dredged from the bottom of the sea in unpolluted regions were found to contain coli-like microbes in less than half the number of experiments, and to contain typical B. coli in only a few instances. Moreover, the positive results which were obtained as regards typical B. coli, and often those also in respect of coli-like microbes, were not achieved except by submitting to cultural tests a whole fish or at least the whole of its alimentary tract. Further, it has just been shown that in deep sea oysters even coli-like microbes are seldom detectable. These deep sea oysters, be it noted, had been obtained from localities not far distant from where the fish were dredged.

Though few hypotheses worthy of the name can be proved absolutely to be devoid of foundation, the balance of evidence is in the present instance clearly against the supposition that the excreta of fish living in unpolluted *deep* sea water are likely to be a fertile source of the contamination with B. coli of either the water or shell-fish. As regards fish frequenting *sewage-polluted* sea water the case may be widely different; but this other aspect of the question lies outside the scope of the present investigation. The experiments now in question deal with the bacterial flora of fish dredged in unpolluted *deep* sea water. In *shallow* estuarial waters, even when they are remote from sewage pollution, the results need not necessarily be in all respects similar.

Section III.

Various experiments bearing on the ability of fish to infect water with B. coli.

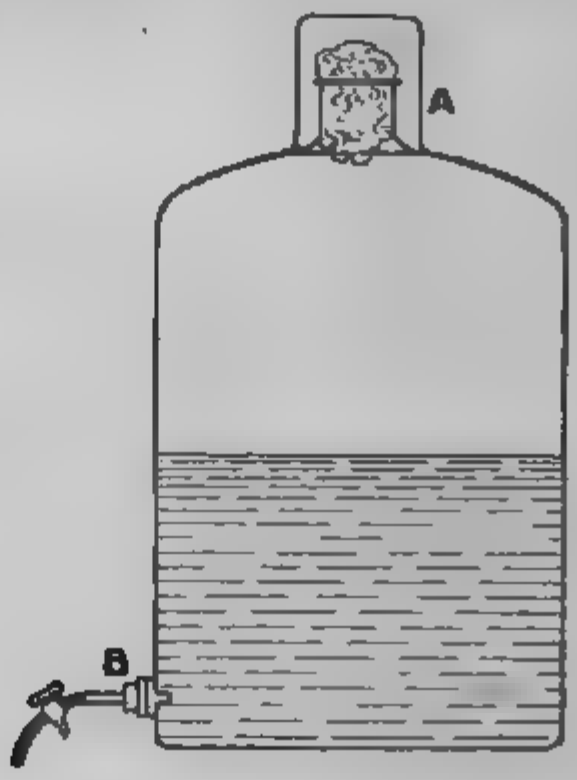
It will be convenient to consider the results under Section III. in the following order:—

First series of experiments.
Second " " "
Third " " "
Fourth " " "
Fifth " " "
Sixth " " "
Summary of results.
Conclusions.

*First series of experiments.**

(First Part.)

The apparatus shown below was sterilised, and partially filled with sterile tap water (3,000 cc.).



Three gold fish were placed in a large beaker containing tap water. The water was renewed in the beaker several times on the same day, by carefully tilting the beaker so as to allow most of the water to run out without the fish escaping and then adding fresh water. The experimenter's hands were next sterilised, so far as this is possible, and a gold fish was seized and held in the palm of the right hand, while with the left hand it was douched with sterile water. The fish was then allowed to drop into the apparatus at A. The other two fish, treated in the same way, were dropped into the apparatus. Throughout the course of the experiment the fish were fed in the apparatus with ants' eggs, previously heated to 80° C. for 30 minutes.

The next day (first day after commencement of the experiment) 100 cc. of the water were run off at B and were added to 100 cc. of double strength bile salt glucose peptone medium contained in a flask; 100 cc. of sterile tap water being poured into the apparatus at A to replace the 100 cc. withdrawn for cultural purposes. The culture was incubated at 37° C. for two days. No gaseous fermentation of the medium occurred. The culture, therefore, was free from glucose-fermenting coli-like microbes of any kind.

On the second day, the above procedure was repeated except that four separate 100 cc. cultures were made and a corresponding amount of sterile tap water added at A. The result of incubation of the cultures was again negative.

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* A careful consideration of all these series of experiments will, I think, convince the reader that the conditions of the experiments were most severe; they were purposely contrived to refute, if possible, my own personal belief in the practical utility of the B. coli test.

On the third day, five 100 cc. cultures were made and 500 cc. of sterile water were added at A. The result was again negative.

The above procedure was repeated on the fourth, fifth, sixth, seventh, eighth, ninth, tenth, and eleventh days. But none of the cultures yielded gas. It will be noted that by the seventh day the original 3,000 cc. of water had been completely renewed, and that by the eleventh day 5,000 cc. of the water had been submitted to cultural tests always with negative results.

To this stage, then, it could be said that three fish, living in 3,000 cc. of water for 11 days, failed to pollute water withdrawn at the outlet, amounting altogether to 5,000 cc., *all* of which was submitted to cultural test; *i.e.*, neither B. coli nor coli-like microbes were found in any section of the 5,000 cc.

On the 13th day,* 10 successive lots of 100 cc. were withdrawn at B for cultural purposes (cultures A, B, C, D, E, F, G, H, I, J), 1,000 cc. of sterile water being added at A to replace the above. As regards the cultures A, B, C, D, E, F, G, H, I, J, all formed acid and gas, and in each case secondary cultures revealed the presence of B. coli or coli-like microbes. In view of the negative results obtained in the case of all the preceding cultures this result may seem surprising. Nevertheless, 100 cc. is, bacteriologically speaking, a large volume of water to submit to cultural tests. Even at the present day many workers record a water as sterile if it contains no microbe in one-hundredth part of the foregoing amount. Possibly the result is to be traced to the fact that ants' eggs were added daily in much larger amount than was necessary to appease the appetite of the gold-fish. Accumulating in the apparatus these ants' eggs would afford pabulum to any B. coli or coli-like microbes, presumably derived from the fish, and might, I think, allow such microbes to display feeble recuperative power and undergo such slight multiplication as would explain their presence in 100 times the volume of water which has been suggested as a standard for the B. coli test. The biological characters of these microbes were as follows:—

—	A.	B.	C.	D.	E.	F.	G	H.	I.	J.
Gelatine "shake" cultures (+ = gas formation)	+	+	+	+	+	+	+	+	+	+
Lactose peptone cultures (+ = acid and gas formation).	+	+	+	+	+	+	+	+	+	+
Neutral red broth cultures (+ = greenish-yellow fluorescence).	+	+	+	+	+	+	+	+	+	+
Broth cultures (+ = indol formation)	-	-	-	-	-	-	-	-	-	+
Litmus milk cultures (+ = acid and clot) ..	+	+	+	+	+	+	+	+	+	+

It will be noted that a microbe from J alone formed indol. In all other respects, however, microbes from A, B, C, D, E, F, G, H, and I were, on the basis of the tests employed, typical B. coli.

* By the evening of this day one of the fish had succumbed; it was extracted from the apparatus with a sterile bent wire.

Summarising these results, it may be said that three fish lived in 3,000 cc. of water for 13 days. During this time 6,000 cc. of outlet water were tested for B. coli in lots of 100 cc. (60 cultures). An equivalent amount of sterile tap water was each day added to replace the water abstracted for cultural purposes. By the 11th day the first fifty 100 cc. cultures had all yielded negative results. On the 13th day the last ten 100 cc. cultures all yielded positive results as regards coli-like microbes, and one of these contained apparently typical B. coli.

(Second Part.)

The water was next inoculated at A with a strong emulsion of B. coli. After thorough mixing of the water 10 cc. of the water were withdrawn and a series of dilutions made in the customary manner and the number of B. coli present determined. The number was one million B. coli per cc. of water.

The 13th day thus ended with two instead of three fish in 3,000 cc. of water containing one million typical B. coli per cc.

On the 14th and subsequent days further procedure was as follows:—1,000 cc. of water were withdrawn daily at B, and the number of B. coli per cc. estimated. On each occasion 1,000 cc. of sterile water were added at A to replace the 1,000 cc. withdrawn for cultural purposes. It is obvious that apart from the question of the viability of the added B. coli the addition daily of the *sterile* tap water to replace the amount withdrawn for cultural purposes would progressively diminish the number of added B. coli per unit of volume. The theoretical number of B. coli is, therefore, in what follows given side by side with the actual results; that is, note is made of the number of B. coli that would have been present in the water if no loss of vitality among them had occurred.

	After addition of B. coli to contents of apparatus, as explained in the text.	Actual number of B. coli per cc.	Theoretical number of B. coli per cc.
	13th day, start of *second part* of experiment ..	1 million	—
1,000 cc. withdrawn daily for cultural tests. 1,000 cc. sterile water added daily to replace that withdrawn.	14th „ (1st day after)	100,000	1 million
	15th „ (2nd „ „)	100	66,666
	16th „ (3rd „ „)	100	44,444
	17th „ (4th „ „)	100	29,630
	18th „ (5th „ „)	100	19,752
	*19th „ (6th „ „)	100	13,168
	20th „ (7th „ „)	100	8,778
	†21st „ (8th „ „)	10	5,852

* Another fish died, leaving only one. The dead fish was removed.
† The remaining fish died and was removed.

It will be noted that there was a rapid diminution in the number of B. coli between the 1st and 2nd day after the start of the second part of the experiment. Thus, on the 1st day after

the start of the experiment the number was 100,000 instead of 1,000,000, and that on the following day the number was only 100 instead of about 66,000. A similar number of B. coli was found in the water drawn off on the 3rd, 4th, 5th, 6th, and 7th days. On the 8th day after the start of the new experiment the number was reduced to 10 B. coli per cc.

The experiment was continued for four days after the fish had died; but no fresh sterile water was added, and only about 12 cc. were withdrawn daily for testing purposes. The number of B. coli remained constant at 100 per cc., and the biological characters of the B. coli isolated on the last day of the experiment (25th day; 12th day after start of new experiment) did not differ from those observed at the commencement of the experiment. Thus, there was no indication of any loss of attribute of the added B. coli as a result of its altered environment. During these later stages of the experiment the water smelt most offensively, and it is possible that the continued vitality of the B. coli was due partly to the filthy condition of the water and to the presence in it of pabulum resulting from the decomposition of the ants' eggs.

Second series of experiments.

The apparatus having been emptied and cleaned was now sterilised and then partially filled with tap water (2,000 cc.). Next a strong emulsion of B. coli, the total scrapings from an agar culture, was added to the water and thereafter two gold fish. After mixing, a small portion of the liquid was withdrawn at B and tested quantitatively for B. coli. The number of B. coli was found to be 100 million per cc. At this stage no ants' eggs or other food was supplied to the fish.

The day after the commencement of the experiment, and thereafter daily, 1,000 cc. of water were withdrawn at B and the number of B. coli estimated. Each day 1,000 cc. of *sterile* tap water were added at A to replace the water withdrawn for testing purposes. In this way, by dilution and apart altogether from the question of viability, the number of B. coli was diminished daily by one-half.

The results were as follows:

Number of days *after* commencement of Experiment.		Actual number of B. coli per cc	Theoretical number of B. coli per cc.
	0	100 millions	—
1,000 cc. withdrawn daily for cultural purposes. 1,000 cc. sterile tap water added daily to replace that drawn.	1	1,000 „	100 millions
	2	100 „	50 „
	3	100,000	25 „
	4	10,000	12½ „
	5	100	6¼ „
	6	100	3⅛ „

At this stage the fish appeared to be dying and so some sterilised bread* was added at A. Nevertheless one of the fish succumbed on the evening of the sixth day, and, moreover, the addition of the bread seemingly led to a multiplication of B. coli. But it is a significant fact that two fish had lived in 2,000 cc. of water containing initially 100 million B. coli per cc. for six days, and that on the fifth day the number of B. coli, instead of being an anticipated 6¼ million, had become actually reduced to only 100 per cc.

The experiment (one fish remaining alive) was continued until the eleventh day with results as follows :—

Number of days *after* commencement of Experiment.		Actual number of B. coli per cc.	Theoretical number of B. coli per cc.
1,000 cc. water withdrawn daily for cultural purposes. 1,000 cc. sterile water added to replace that withdrawn.	7	1,000	1,562,500
	8	10,000	781,250
	9*	10,000	390,625
	10	1,000	195,312
	11	100	97,656

* The remaining fish unfortunately died, and was removed.

The biological characters of the B. coli isolated on the last (eleventh) day of the experiments were identical with those of the B. coli used to inoculate the water. There was thus no indication of any loss of attribute of B. coli as the result of its altered environment.

Third series of experiments.

At this stage of the inquiry the question arose whether the addition daily of fresh *sterile tap* water might not have encouraged B. coli to persist, apart altogether from the presence of the fish, by continuously affording this microbe a small amount of assimilable pabulum. In certain experiments reported on to the Royal Commission on Sewage Disposal, B. coli added in large number, both to sea water and to tap water, either died very speedily or became so reduced in number that it could not be recovered from 1 cc. of a sample. But in those experiments for the Commission the water (not previously sterilised) was kept at a temperature of 20° C. and in stoppered bottles, and no fresh water was added to replace that withdrawn for testing purposes. It does not follow that similar results would have been obtained under other conditions of experiment, as, for instance, in cases where fresh sterile water was, as in the present investigation, constantly being added.

The apparatus having been emptied, cleansed, and sterilised, 2,000 cc. tap water (not previously sterilised) were added. Next, an emulsion of B. coli, derived from an agar culture, was added,

* Sterilized by boiling in a test tube with some water.

and, after mixing, the number of B. coli was determined. This number of B. coli was found to be 100 million per cc.

The day after the commencement of this experiment, and thereafter daily, 1,000 cc. of water were withdrawn at B and tested quantitatively for B. coli. Each day 1,000 cc. of *sterile* tap water were added at A to replace the water withdrawn for testing purposes. In this way, apart altogether from the question of viability, the number of B. coli was diminished daily by one-half.

The results were as follows :—

	Number of days *after* start of experiment.	Actual number of B. coli per cc.	Theoretical number of B. coli per cc.		Number of days *after* start of experiment.	Actual number of B. coli per cc.	Theoretical number of B. coli per cc.
1000 cc. water withdrawn for cultural purposes; 1000 cc. *sterile* tap water added to replace that withdrawn.	0 ..	100,000,000	—	1000 cc. water withdrawn for cultural purposes; 1000 cc. *sterile* tap water added to replace that withdrawn.	13 ..	1	48,828
	1 ..	1,000,000	100,000,000		13 ..	1	24,414
	2 ..	10,000	50,000,000		14 ..	1	12,207
	3 ..	100	25,000,000		15 ..	1	6,103
	4 .	10	12,500,000		16 ..	1	3,051
	5 .	100	6,250,000		17 ..	1	1,525
	6 ..	100	3,125,000		18 ..	1	762
	7 ..	10	1,562,500		19 ..	0	381
	8 ..	10	781,250		20 ..	1	190
	9* ..	1	390,625		21 ..	0	95
	10 ..	1	195,312		22 ..	0	47
	11 ..	1	97,656				

* The biological characters of the B. coli were carefully determined. No loss of attribute as the result of altered environment could be made out.

It will be noted that on the ninth day the number of B. coli was only 1 instead of over 390,000 per cc. But it was not until the 21st day that the absence of B. coli from 1 cc. of the water could be said to be established, and by that time the theoretical number of B. coli was reduced to 95 per cc. It follows, therefore, that although under the conditions of experiment the vast majority of the B. coli rapidly succumbed, the disappearance of this microbe from 1 cc. of the water was a matter of weeks.

These results appear to emphasise the danger of hastily condemning potable waters owing to the mere presence in them of B. coli. No doubt a *pure* culture of a particular strain of B. coli represents a vast number of individuals of different degrees of vitality. Those of feeble vitality (apparently the great majority) perish quickly under unfavourable conditions, whilst the few, but more robust, individuals succumb much less readily.

Fourth Series of Experiments.

The water (2,000 cc.) in the apparatus which now no longer contained B. coli in 1 cc. was again inoculated with an emulsion of B. coli derived from a recent agar culture. In addition, a gold-fish was introduced to it which the day previous had been placed and kept in a beaker of tap water inoculated with an enormous number of B. coli.

After mixing, the initial number of B. coli in the water of the apparatus was determined and found to be one million per cc.

As in the previous experiments, 1,000 cc. of water were withdrawn daily for cultural tests, and 1,000 cc. of sterile tap water added.

The results were as follows :—

Number of days after commencement of experiment.	Actual number of B. coli per cc.	Theoretical number of B. coli per cc.	Number of days after commencement of experiment.	Actual number of B. coli per cc.	Theoretical number of B. coli per cc.
0	1,000,000	—	11 ..	10	976
1 ..	10,000,000	1,000,000	12 ..	1	488
2 ..	100,000	500,000	13 ..	1	244
3 ..	100,000	250,000	14 ..	1	122
4 ..	10,000	125,000	15 ..	1	61
5 ..	10	62,500	16 ..	1	30
6 ..	1	31,250	17 ..	1	15
7 ..	1	15,625	18 ..	1	7
8 ..	1	7,812	19 ..	0	3
9 ..	1	3,916	20 ..	0	1
10 ..	1	1,953			

(1,000 cc. withdrawn daily for cultural purposes; 1,000 cc. sterile tap water added daily to replace the amount withdrawn.)

(1,000 cc. withdrawn daily for cultural purposes; 1,000 cc. sterile tap water added daily to replace the amount withdrawn.)

It is to be noted that the number of B. coli on the sixth day was only 1 instead of above 31,000 per cc. But not until the 19th day was a negative result obtained when using 1 cc. of the water for cultural purposes; and by this time, be it noted, the daily dilution with sterile water had reduced the initial number of B. coli from one million down to 3 per cc. (theoretical number) Here, again, there was no difficulty in showing a rapid diminution in the number of B. coli. But, as before, a few B. coli persisted in the water for a long time.

Fifth series of experiments.

The apparatus having been again cleaned and sterilised, 2,000 cc. of sterile tap water were added. Next the hands of the experimenter having been sterilised a gold fish was picked out of a beaker, washed first under the tap for several seconds, and

afterwards with sterile water. The fish was then dropped into the apparatus at A. The previous history of the fish as regards possibilities or probabilities of coli infection was as follows:—This fish had been kept in a beaker containing tap water, and each day the water had been renewed, and *after* each renewal a large loopful of B. coli from an agar plate culture had been added to the water. This meant the addition daily to the water of millions of B. coli. The fish was meanwhile fed on ants' eggs, and it is hardly conceivable that these could have been swallowed without ingesting then, if not at other times, B. coli in large number. This treatment was carried out for 34 days before fish was added at A.

Each day after starting the experiment 1,000 cc. of water were withdrawn for cultural purposes,* and 1,000 cc. of *sterile* tap water added to replace the amount withdrawn.

The results were as follows:—

Number of days *after* start of experiment.	Results, as regards B. coli.
1,000 cc. withdrawn daily for cultural purposes. 1,000 cc. added daily to replace the amount withdrawn.	
1	Negative result, even in the 100 cc. cultures.
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	"
11	"
12	Typical B. coli present in 10 cc.; none in 1 cc.
13	Negative result, even in the 100 cc. cultures.
14	"
15	"
16	"
17	"
18	"
19	"
20	"
21	"
22	"

* Generally speaking cultures were made with the following volumes of water:—100 cc.; 10 cc.; 1 cc.; $\frac{1}{10}$ cc.; $\frac{1}{100}$ cc.

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On the 22nd day after the inoculation the gold fish died, so the experiment had perforce to be abandoned. The fish was removed from the apparatus, was washed first with tap and then with sterile water, was cut up into several parts with a sterile pair of scissors, and was added to 50 cc. bile-salt glucose peptone medium. After incubation of this medium for two days at 37° C. secondary gelatine plate cultures were made. Only liquefying colonies developed on the plates and no B. coli or coli-like microbes could be found.

It is to be noted therefore that a fish exposed antecedent to experiment for 34 days to gross B. coli infection and subsequently kept for 22 days in only 2,000 cc. of sterile water (one half renewed every day) failed, practically speaking, to pollute such water. In one instance only was B. coli recovered from the 10 cc. culture. Moreover, the fish at the close of the experiment was, as regards B. coli or coli-like microbes, found to be sterile.

Sixth series of experiments.

This was, practically speaking, a repetition of the last experiment. But the fish now in question had been exposed to gross B. coli infection for 43 days before being added to the sterile tap water in the apparatus. Further, the 1,000 cc. of water were withdrawn for cultural purposes (a similar amount of sterile tap water being added to replace it) every second day instead of each day.

The results were as follows :—

Number of days *after* start of experiment.	Results, as regards B. coli.
2	Typical B. coli present in 100 cc., 10 cc., and 1 cc. cultures
4	Typical B. coli present in 100 cc., negative result 10 cc.
6	" " " "
8	" " " "
10	Negative result, even in the 100 cc. cultures.
12	" " "
14	" " "
16	" " "
18	" " "
20	" " "
22	" " "
24	" " "
26	" " "
28	" " "
30	" " "

It is to be noted that although B. coli was present in small number in the water during the early stages of the experiment, this microbe could not be recovered even from 100 cc. of the water from the 10th to the 30th days after the start of the experiment.

On the 32nd day a second gold fish was, after washing first with tap water and then with sterile water, added to the water in the apparatus. This fish had been exposed in like fashion to the other to coli infection for a period of 30 days.

The results were as follows :—

Number of days *after* start of experiment.	Results, as regards B. coli.
32	Typical B. coli present in 100 cc., 10 cc., and 1 cc. cultures.
34	Negative results, even in the 100 cc. cultures.
36	Typical B. coli present in 10 cc., negative result 1 cc.
38	Negative result, even in the 100 cc. cultures.
40	" " " " "
42	" " " " "
44	" " " " "
46	" " " " "
48	" " " " "

On the 50th day both the fish were removed, killed, severally cut up into bits with sterile scissors, and added to 50 cc. bile-salt glucose peptone tubes. After two days' incubation at 37° C. secondary gelatine plate cultures were made. Only liquefying colonies appeared on the plates, and no B. coli or coli-like microbes were found.

These results can only be interpreted in one way, namely, that gold fish afforded sustained opportunity previously for gross B. coli infection cannot, under the conditions of experiment, pollute subsequently a pure water in which they are made to live. There was no evidence of any continuous infection by them of the water, the few B. coli observed in the early cultures rapidly disappearing, notwithstanding the fact that as much as 100 cc. of water were used for cultural purposes.

Moreover, the fish at the close of the experiment were themselves free from B. coli or coli-like microbes.

Summary of results: Section III.

In connection with each separate series of experiments a brief summary has already been given, with usually some provisional conclusions. I now proceed to draw attention in a broad and general way to some of the more important facts obtained during this investigation.

In the first part of a first series of experiments in Section III., it was shewn that three gold fish living in 3,000 cc. of sterile water for 13 days effected the following results as regards contamination of the outlet water with B. coli or coli-like microbes: 6,000 cc. of outlet water were tested for B. coli in 60 lots of 100 cc. each. A similar bulk of sterile water was always added to replace that withdrawn for cultural purposes. The first 50 lots of 100 cc. yielded negative results, the last 10 lots of 100 cc. yielded coli-like microbes, and in one instance typical B. coli on the basis of the tests employed.* It should be noted that *all* the outlet water was subjected to cultural tests.

In the second part of the first series of experiments the 3,000 cc. of water in the apparatus were inoculated with a typical strain of B. coli, the estimated number being 1,000,000 per cc. 1,000 cc. of water were withdrawn daily for cultural purposes, and a similar volume of sterile water added to take its place. At first (six days) two gold fish were present in the water, then one (two days more), afterwards none. The second day after the start of the experiment the theoretical number of B. coli was 66,666, but the actual number found was only 100 per cc. The ascertained number of B. coli remained practically constant at 100 per cc. until the close of the experiment (12th day). During the last four days, however, no fresh sterile water was added, and the water in the apparatus had become exceedingly foul, probably due to the accumulation of the ants' eggs previously added for feeding purposes.

In a second series of experiments two gold fish lived for six days in 2,000 cc. of water containing initially 100 millions B. coli per cc. By the 5th day the actual number of B. coli was 100 instead of 6¼ million (theoretical number) per cc. Nevertheless, on the 11th day, the actual number of B. coli was still 100 per cc., although the theoretical number had fallen to 97,656. The addition of sterilised bread during the last few days of the experiment may in this instance have helped to preserve the vitality of B. coli.

In a third series of experiments no gold fish were used, the object being to discover whether B. coli could survive for any length of time in a pure tap water if fresh sterile tap water was added to it daily in large amount to replace the water withdrawn for cultural purposes. On the ninth day the number of B. coli was 1 instead of 390,625 (theoretical number) per cc. But it was not until the 21st day that absence of B. coli from 1 cc. could be said to have been established, by which time the theoretical number of B. coli was only 95 per cc.

In a fourth series of experiments the conditions remained very much the same as in the third, except that a gold fish was placed in the water which had been exposed for 24 hours to opportunity of gross coli infection. On the 6th day the number of B. coli was only 1 instead of 31,250 (theoretical number) per cc. But not until the 19th day was a negative result obtained when using 1 cc.

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* *See* footnote in connection with this series of experiments.

of the water for cultural purposes, by which time the theoretical number of B. coli was only 3 per cc.

In a fifth series of experiments a gold fish previously exposed for 34 days to gross coli infection was, after douching first with tap and then with sterile water, added to 2,000 cc. of sterile water. 1,000 cc. of water were afterwards withdrawn daily for cultural purposes, and 1,000 cc. of sterile water added to take the place of the amount withdrawn. On the 12th day a positive result as regards B. coli was obtained. On all other occasions the result was negative, even when 100 cc. of the water were used for cultural purposes. This fish at the end of the experiment (22nd day) contained no B. coli.

A sixth series of experiments were carried out on practically similar lines, and with results broadly parallel to the foregoing.

Conclusions; Section III.

It is no easy task to attempt to draw conclusions from experiments carried out under such variable conditions. Moreover attempt at interpretation of the facts ascertained during the enquiry necessarily raises points open to much dispute. Few biological investigations yield results which allow of an absolute answer being given to the problems which they have sought to solve. In what follows endeavour has been made to avoid being governed by personal impressions or convictions and to base conclusions on impartial consideration of all facts of the case.

The first part of the first series of experiments seems to show that gold fish previously fed in ordinary fashion and kept under ordinary conditions have little power of contaminating sterile water with B. coli by means of their excrement.

The second part of the first series of experiments appears to indicate that B. coli diminishes rapidly in water even when gold fish are present. But it also suggests that if a water be in a foul and dirty condition a certain proportion of B. coli persists for a considerable time.

The second series of experiments yielded somewhat similar rasults to those obtained in the second part of the first series of experiments.

The third series of experiments seemed to show that B. coli rapidly diminishes in number in pure tap water even when fresh sterile tap water is added daily to it in large amount. But it is also obvious that the complete disappearance of B. coli from the water under the conditions of experiment may be a matter of weeks.

The fourth series of experiments went to support the foregoing conclusions, notwithstanding the presence in the water of a gold fish previously exposed for 24 hours to gross B. coli infection.

The fifth and sixth series of experiments appeared to prove that gold fish exposed for long periods to gross coli infection have no power to seriously pollute, quâ B. coli, a pure water, and that when the fish some time afterwards are subjected to cultural tests no B. coli can be found in them.

In conclusion, it must be remembered that what is true as regards gold fish need not necessarily hold good as regards other fish. Subject to this important qualification, I think that the results as a whole go to show definitely that the presence of fish in water is not likely to create or foster a serious or continuous B. coli infection of such waters or to render the results of their bacterioscopic analysis of doubtful value in relation to the detection of objectionable contamination. At the same time many of the results afford a strong indication of the danger of stringent B. coli standards; nevertheless they suggest justification for the imposition of standards of a lenient kind.

DIVISION III.

Results of Bacteriological Examination of certain Public Wateb Supplies.

App. B, No. 7. Report on Bacteriologic Examination of (1) Excreta of Man; (2) Excreta of Sea-fowl and Fish; and (3) certain Potable Waters; by Dr. Houston.

I. Effect of storage and filtration considered from the biological point of view.

A. Methods and procedure.

B. Explanation of symbols, &c., appearing in the various tables.

II. Results of the bacteriological examination of London filtered waters.

III. Analysis of the results:—

(1.) B. enteritidis sporogenes test:

(2.) B. coli test:

(*a.*) Total number of coli-like microbes.

(*b.*) Number of typical B. coli.

(*c.*) Comparison between the number of—

(*a.*) Coli-like microbes, and

(*b.*) Flaginac B. coli.

(*d.*) Grouping of the B. coli and coli-like microbes from filtered waters according to their biological attributes,

(*e.*) Comparison between the results of the *prima facie* or presumptive test for B. coli and the number of B. coli or coli-like microbes actually isolated from the various filtered waters.

IV. Summary and conclusions.

Effect of Storage and Filtration considered from the biological point of view.

The beneficial effect of storage followed by sand filtration such as is practised by the various London Water Companies, in reducing the *total number of microbes* in the raw Thames and Lea waters was shown conclusively by the Franklands, during their prolonged and able investigations carried out from 1885 to 1892

But even at the time of writing (July 1904), the collective effect of storage and sand filtration in *eliminating or in modifying the biological attributes of microbes of an intestinal type* derived from the unfiltered impure Thames and Lea waters, is not it would seem fully understood.

This matter is of wide importance. Because on the one hand the source of London water supply is on bacterial evidence proved to be polluted by sewage, while on the other hand statistical evidence points to a comparatively low incidence of enteric fever on the metropolis. How can these seemingly conflicting facts be reconciled? Is mere proof of large reduction of total microbes a completely satisfactory solution of the problem; and does past epidemiological experience suffice to the conclusion that a gross pollution of a water supply, albeit of non-specific character, will continue to be harmless, despite experience that a seemingly trivial contamination, but of specific sort, of such supply can at once cause wide-spread disease? In my view proof of reduction of the total number of micro-organisms in the filtered water, as compared with the total number in the raw water before storage and filtration, affords by itself no convincing explanation of what at first sight would seem a biological paradox. If sewage is to be regarded as potentially dangerous to health it is because sooner or later the comparatively harmless rank and file of excremental bacteria may be accompanied by the specific germs of disease. Though storage and filtration of water may remove 99 out of each 100 intestinal bacteria present in it, the remaining microbe which thus passes the barrier of the filter beds and so reaches the consumer must according to the law of probabilities, and if no no further explanation be forthcoming, at some time prove to be a specific micro-organism. Nevertheless the fact remains that London has in the matter of the water supply escaped any tangible lethal effects of a pathological test on a vast scale spread over a long term of years. The explanation lies probably in the fact that bacterially the matter is one not merely of degree but of intrinsic difference. The considerations I am adducing may be expressed arithmetically somewhat as follows :—

A given Water Company abstracts water from the Thames at the rate of about 20 million gallons per day,

$$1 \text{ gallon} = 4{,}546 \text{ cc.; and } 4{,}546 \text{ cc.} \times 20 \text{ millions} = 90{,}920{,}000{,}000 \text{ cc.}$$

The Thames in the region of such company's intake is found to contain, say, per cc. B. coli or coli-like microbes in the following proportions :—

At least 1 but less than 10 per cc. in 11·77 per cent. of samples tested.

At least 10 but less than 100 per cc. in 64·77 per cent. of samples tested.

At least 100 but less than 1,000 per cc. in 17·67 per cent. of samples tested.

At least 1,000 but less than 10,000 per cc. in 5·97 per cent. of samples tested.

Adopting the figures of 10 per c.c. (an under-estimate) it thus appears that 909,200,000,000 B. coli or coli-like microbes are daily abstracted along with its Thames water by such company. Assuming that the storage and filtration practised by the company reduces this number one-hundred-fold, there would yet remain on the above assumption over nine thousand million B. coli or coli-like microbes which might in a single day enter the supply mains and be distributed to consumers.

It further appears from certain analyses which I have made that 76·5 per cent. (three-quarters) of the coli-like microbes isolated from the raw Thames water at Hampton give, when tested in pure culture, the following reactions:—"Gas" in gelatine "Shake" cultures; indol in broth cultures; and acid and clot in litmus milk cultures.

Hence, theoretically, on the basis of the tests employed, about 6,750 million *typical B. coli*, out of a total of 9,000 million coli-like microbes, may in one day be entering the supply mains of the given company.

The proportion may be stated in another way:—

The raw Thames water at Hampton, according to my results, contains:—

In 11·7 per cent. of the samples at least 1 but less than 10 B. coli or coli-like microbes per cc.

In 64·7 per cent. of the samples at least 10 but less than 100 B. coli or coli-like microbes per cc.

In 17·6 per cent. of the samples at least 100 but less than 1,000 B. coli or coli-like microbes per cc.

In 5·9 per cent. of the samples at least 1,000 but less than 10,000 B. coli or coli-like microbes per cc.

Above 75 per cent. of these coli-like microbes are, on the basis of the tests employed, typical B. coli. Even if the one-hundred-fold reduction be assumed as the result of storage and filtration the consumers would still be obliged on theoretical grounds to drink coli-like microbes, three-quarters of which are typical B. coli (on the basis of the tests employed) in the following proportions:—

At least 1 per 100 cc. but less than 1 per 10 cc. in 11·7 per cent. of the samples.

At least 1 per 10 cc. but less than 1 per 1 cc. in 64·7 per cent. of the samples.

At least 1 per 1 cc. but less than 10 per 1 cc. in 17·6 per cent. of the samples.

At least 10 per 1 cc. but less than 100 per 1 cc. in 5·9 per cent. of the samples.

The foregoing figures, except so far as they refer to actual raw Thames water, are purely suppositional. Moreover, they do not take note of the circumstance that the Company in question is credited with the habit of rejecting storm water for storage purposes. They serve, however, to emphasize the point that unless some explanation be forthcoming (other than mere percentage reduction of the total bacterial flora) the comparative immunity from enteric fever enjoyed by the consumers of London water is explicable only on the supposition that water polluted with sewage is less dangerous than has been supposed.

Explanation, therefore, of immunity from water-borne disease on a purely mechanical or arithmetical basis, without consideration of possibly superadded intrinsic modification of the biological qualities of an impure water during the processes of storage and filtration, cannot be accepted as entirely satisfactory.

It remains to be determined how far the observed low incidence of enteric fever in the Metropolis may be referred to modification of the original objectionable biological qualities of the raw Thames and Lea waters, involved in the mechanical processes of prolonged sedimentation and efficient sand filtration to which this water is subjected by the water companies.

A. *Methods and procedure.*

The water samples were collected in sterile bottles either at the companies' works (marked W in tables) or from mains or water posts (marked M in tables). No samples of *tap* water (*i.e.*, water after storage in a cistern) are included.

B. enteritidis sporogenes test.—Ten cc.* of the water were added to a wide tube containing 50 cc. of sterile milk. The tube, antecedent to inoculation, was placed in boiling water and kept there for several minutes to drive off the dissolved oxygen and then rapidly cooled. The tube after inoculation was heated to 80° C. for 15 minutes, placed under anaerobic conditions, and incubated at 37° C. for two days.

B. coli test.—The primary cultures were made in bile-salt glucose peptone medium.

(*a*) 100 cc. of the water were added to a flask containing 100 cc. of double strength medium.

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* In a considerable number of instances as much as 100 cc. was submitted to examination by adding 100 cc. of the sample to large tubes containing 50 cc. of a milk medium (milk, 1,000; lactose, 20; peptone, 20; sodium carbonate, 1.) These records are not included in the tables.

(*b*) 10 cc. of the water were added to a tube containing 10 cc. of double strength medium.

(*c*) 1 cc. of the water was added to a tube containing 10 cc. of single strength medium.

Ten cc. of the water were added to 90 cc. of sterile water (dilution (1)). 10 cc. of dilution (1) were added to 90 cc. of sterile water (dilution (2)). 10 cc. of dilution (2) were added to 90 cc. of sterile water (dilution (3)).

1 cc. severally of dilutions (1) (2) (3) were added respectively to 10 cc. bile-salt glucose peptone tubes (*d*, *e*, and *f*) representing respectively $\frac{1}{10}$, $\frac{1}{100}$, and $\frac{1}{1000}$ cc. of the sample of water.

These six primary cultures (*a*, *b*, *c*, *d*, *e*, *f*) were incubated at 37° C.

On the second day observations as regards acid and gas production (*primâ facie* test) were made.

Those cultures in which no gas developed were discarded as conclusively proving the absence of glucose fermenting coli-like microbes of any sort. But from the primary cultures forming both acid and gas secondary gelatine plate cultures were made.

The secondary gelatine plate cultures were incubated at 20° C. for 24 to 48 hours. The coli-like colonies (the filmy colonies in preference) were picked off and subcultured in gelatine (shake culture). If no gas developed the culture was discarded. But, if gas was produced, the microbe was regarded as a coli-like microbe, and further cultures were made as follows:—

Neutral red broth cultures (for observation as regards greenish yellow fluorescence, within 48 hours at 37° C.). Lactose peptone cultures for observation as regards acid gas production within 48 hours at 37° C.). Broth cultures (for observation as regards indol production, within five days at 37° C.). Litmus milk cultures (for observation as regards acid clotting of the medium, within five days at 37° C.).

[To subculture into the foregoing media *directly* from the primary culture (that is, to inoculate these media with a mixture of microbes), some perchance lactose fermenting, others indol producing, yet others again capable of producing a fluorescent change in neutral red broth may yield results of value. But to express results in terms of B. coli without any indication of the means by which the results were obtained is most misleading.]

The original gelatine "shake" cultures were kept for one month for observation as regards liquefaction of the gelatine.

B. *Explanation of Symbols, &c. appearing in the various Tables.*

To express the results of subcultural tests of the coli-like microbes isolated in pure culture the word "flaginac" is used in the following sense :—

fl = indicates greenish fluorescence in neutral red broth cultures.

ag = indicates acid and gas in lactose peptone cultures.

in = „ indol formation in broth cultures.

ac = „ acidity and clotting of litmus milk.

The word "flaginac" thus indicates that a microbe was indistinguishable, as regards the tests employed, from the typical B. coli of the human intestine. When the letters are placed in brackets an incomplete reaction is indicated. The absence of a character is expressed by the omission of the letters chosen to indicate that attribute. When the sign "0" occurs it means that beyond forming gas in gelatine shake cultures the microbe yielded negative results with all the other tests.

The letter L signifies that the microbe proved to be a slow liquefier of gelatine. The letters L Y mean that the microorganism not only liquefied gelatine but was chromogenic (yellow).

The letter F indicates that although the primary culture formed acid and gas failure was experienced in the attempt to isolate coli-like microbes from the secondary gelatine plate cultures.

The Letters N S C mean that no secondary cultures were made.

As previously explained, the letter W refers to a "works" sample, and the letter M to a "main" sample.

As regards the B. enteritidis sporogenes test the letters N V and V indicate that the milk culture was either non-virulent (N V) or virulent (V) in rodents.

II. Results of the Bacteriological Examination of London Filtered Waters.

In the following seven tables (Ic. to VIIc.) the results are shown of the bacteriological examination of *filtered* water supplied to the consumers by companies drawing water from the Thames or Lea or from both sources.

My records of the bacteriological condition of the Thames and Lea waters *after* storage and *before* filtration are not sufficiently numerous for definite statement as to the effect on the biological condition of the water of sedimentation alone. But it is beyond dispute that prolonged storage may effect an important change in

the biological quality of a water. Filtration is after all either a purely mechanical or a bio-mechanical process, and must needs be fairly rapid to be adopted in practice. Storage on the other hand if sufficiently prolonged not only reduces the total number of microbes by sedimentation and by slow processes of natural destruction, but seemingly also brings about what may be termed a selective bacterial death rate. Moreover, there is some evidence to show that short of actual loss of viability there occurs to bacteria a gradual weakening or loss of attributes which were initially possessed by them. It is by no means unlikely that a *specifically* polluted water may, if stored for a sufficient length of time, become quite harmless, owing either to total extinction of pathogenic bacteria or to, what practically comes to the same thing, loss by such bacteria of their specific properties.

Unfortunately, in practice it is difficult to ensure not only that the average period of storage is sufficiently long but also to fix a minimum period that must not be transgressed. Figures showing the maximum number of days a water may be stored are apt to be misleading. On occasion the actual number of days' storage may be very much less than is implied by the figures.

It needs to be remembered that even if the bacteriological results do not, as the consequence of storage of a water, prove great reduction in the number of the objectionable microbes, nor an apparent alteration in their attributes, it does not necessarily follow that the specific qualities of bacteria pathogenic to human beings have not become modified or altogether lost in the process. Indeed it is possible that the *bacterioscopic* results may be sometimes misleading. It appears, for example, conceivable that filtration might produce a more apparent than real, and storage a more real than apparent, change in the specific properties of the microbes present in a liquid. That is, filtration might produce a very notable reduction in the number of bacteria without modification of their intrinsic properties, while storage though producing a less pronounced reduction in number might exert a very notable modification of the specific properties of the bacteria. Storage, in other words "delay," may be a much more potent factor in preventing the spread of disease by water than is generally supposed or than the bacteriological facts, as to numbers, morphology, and cultural features, reveal.

As previously noted, my records of the biological condition *after* storage but *before* filtration, of the Thames and Lea waters are not sufficiently numerous to merit special consideration. But it may not be amiss if I describe the results of a few analyses bearing on this subject.

I was particularly impressed with the relatively pure condition of unfiltered river water in a channel feeding certain sand filters. This water represents the raw river water after passing through large subsidence reservoirs.

A sample collected on June 23rd, 1903, yielded 10 coli-like microbes per cc. But the coli-like microbes representative in this instance of both the $\frac{1}{10}$ cc. and the 1 cc. primary cultures were

markedly atypical (type 0, see previous notes). Moreover, this sample contained no spores of B. enteritidis sporogenes in 10 cc

A sample collected from the same source on June 27th, 1903, contained "flag(in)ac" B coli in 10 cc., but no coli-like microbes of any sort in 1 cc. There were no spores of B. enteritidis sporogenes in 10 cc. of this sample.

Another sample collected on July 8th, 1903, contained "(fl) in (ac)," B. coli in 10 cc., and "flag" B. coli in 100 cc. There were no spores of B. enteritidis sporogenes in 10 cc.

A further sample collected on September 30th, 1903, actually failed to yield any coli-like microbes when 100 cc. of the water were submitted to cultivation. There were no spores of B. enteritidis sporogenes in 10 cc.

Reverting once more to the filtered waters the following seven tables (Ic. to VIIc.) deal with the biological condition of seven London companies' waters after filtration.

Table Ic.

Results of the Bacteriological Examination of Filtered Water as Supplied to the Consumers by Water Company, A.

Number.	1903. Day.	1903. Month.	Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in :— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
1 M.	5	6	N S C +	flaginac +	flagac + L	−			−
2 M.	9	"	N S C +	flac + L	(fl)ac + L	−			−
3 M.	10	"	N S C +	fl + L	(fl) + L	−			−
4 M.	11	"	N S C +	flagac +	flagac +	−			−
5 M.	15	"	flag(in)ac +	fl +	−				−
6 M.	16		+	0 + L	flaginac +	−			−
7 M.	17		flaginac +	−					−
8 M.	22	"	flinac + L	flaginac +	−				−
9 M.	26	"	+	flaginac +	flaginac +	−			−
10 M.	29	"	flaginac +	flaginac +	−				−
11 W.	1	7	flaginac +	−					−
12 W.	14		N S C +	fl + L	−				−
13 W.			N S C +	(ag)ac +	ag +	−			−
14 W.	6	8	−						−
15 W.	"	"	flagac +	flag(in) +	0 + L	−			−
16 M.	11	"	−						−
17 M.	12	"	flag(in)ac +	(fl)(in)(ac) + L	flag(in)ac +				−
18 M.	19	"	aginac +	(ag) + L	fl + L	−			−
19 W.	20	"	flaginac +	flaginac +	flaginac +	−			−
20 W.	8	9	flaginac +	flaginac +	flagac +	−			−
21 W.	"	"	flaginac +	F +	flagac +	−			−
22 W.	"	"	flaginac +	flaginac +	flaginac +	−			−

N.B.—For explanation of symbols, see text under Ib.

TABLE IC—*continued.*

Number.	1903. Day.	1903. Month.	Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in :— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
23 W.	15	9	flaginac +	flaginac +	−				−
24 W.	„	„	fl +	(fl)X(ag)ac + L	(fl)X(ag) + L	−			−
25 W.	23	„	flagac +	flagac +	flag +	−			−
26 M.	8	10	flagac +	flagac +	−				−
27 W.	6	„	flag +	fl(ag) +	−				−
28 W.	12	„	flagac +	fl +	−				−
29 W.	„	„	flagac +	(fl)ag +	−				−
30 W.	19	10	flaginac +	flaginac +	flaginac +	flaginac +	−		−
31 W.	„	„	flaginac +	flaginac +	flaginac +	−			−
32 W.	21	„	flagac +	flaginac +	−				−
33 W.	27	„	flagac +	flaginac +	(fl)ac +	flag(in)ac +	(fl) +	—	+ V
34 W.	„	„	0 +	flaginac +	flaginac +	−			−
Biological attributes of the B. coli and coli-like microbes.			10 flaginac 7 flagac 1 0 2 flag(in)ac 1 fl 1 flag 1 flinac 1 aginac 1 Liquefier	13 flaginac 3 flagac 1 0 4 fl 1 (ag) 1 flac 1 (ag)ac 1 flag(in) 1 (fl)X(in)X(ac) 1 (fl)X(ag)ac 1 fl(ag) 1 (fl)ag 7 Liquefiers	7 flaginac 4 flagac 2 fl(ac) 1 (fl) 1 ag 1 0 1 flag(in)ac 1 fl 1 (fl)(ag) 1 flag 6 Liquefiers	1 flaginac 1 flag(in)ac	1 (fl)		

N.B.—For explanation of symbols, *see* text under IB.

Table IIc.

Results of the Bacteriological Examination of Filtered Water as Supplied to the Consumers by Water Company B.

Number.	1903. Day.	Month.	Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in :— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
1 M.	5	6	0 + L	flagac + L	−				−
2 M.	9	„	flaginac +	−					−
3 M.	10	„	flaginac +	flaginac +	−				−
4 M.	11	„	flagac + L	flaginac +	−				−
5 M.	16	„	fl + L	flaginac +	−				−
6 M.	17	„	+	flaginac +	flaginac +	−			+
7 M.	19	„	flagin +	flac + L	(fl)in +	−			−
8 M.	23	„	flac + L	flinac + L	−				−
9 M.	26	„	F + *	flac + L	−				−
10 M.	29	„	flaginac +	−					−
11 M.	18	„	N S C +	N S C +	fl + L	−			+ N V
13 M.	„	„	flaginac +	flagac +	−				? −
13 W.	24	„	fl + L						−
14 W.	„	„	−						−
15 M.	26	„	fl + L	−					−
16 M.	„	„	flaginac +	−					−
17 M.	„	„	flaginac +	fl + L	−				−
18 W.	27	„	−						−
19 M.	1	7	flaginac +	flaginac +	−				−
20 M.	„	„	flinac +	−					−
21 M.	„	„	−						−
22 M.	„	„	0 + L	−					−
23 M.	„	„	flaginac +	−					−
24 M.	„	„	(fl)(ag) + L *	(fl)(ag) + L	(ag)(in) + LY	−			−
25 M.	„	„	(fl) + L	−					−

* Virulent B. pyocyaneus isolated from 100 cc. of this sample.

N.B.—For explanation of symbols, see text under IIa.

TABLE IIC—*continued.*

Number.	1903. Day.	1903. Month.	Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in :— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
26 M.	1	7	flaginac +	flagin +	−				−
27 W.	3	„	−						−
28 W.	„	„	fl(ag) + L	fl(ag) + L	−				−
29 M.	10	„	flag +	(in)ac +	−				−
30 M.	„	„	agin + LY	−					−
31 M.	„	„	flac + L	flag + LY	−				−
32 W.	„	„	fl +	−					−
33 M.	20	„	flaginac +	flac +	−				−
34 M.	„	„	flagac +	F +	0 +	−			−
35 M.	„	„	F +	flaginac +					−
36 M.	„	„	fl(ag)ac + L	(ag)ac + LY	−				−
37 W	„	„	flaginac +	−					? −
38 W	„	„	flagac +	−					−
39 W.	5	8	flag +	−					
40 W.	„	„	−						
41 M.	„	„	flagin + L	flaginac +					
42 W.	10	8	−						−
43 W.	„	„	flaginac +	−					−
44 W.	„	„	−						−
45 M.	11	„	−						−
46 M.	„	„	(fl)agac +	flagac +	(fl)agac +	−			−
47 M.	17	„	F +	F +	0 +	−			
48 M.	„	„	flagac +	flagac +	flagin + L				−
49 W.	25	„	flaginac +	−					−
50 W	26	„	flaginac +	−					
51 W.	„	„	flaginac +	−					−
52 M.	1	9	F +	0 + LY	−				−

N.B.—For explanation of symbols, see text under 1B.

TABLE IIc—*continued.*

Number.	1903. Day.	Month.	Presence (+) or absence (–) of B. coli or gas-forming coli-like microbes in :— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (–) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
58 M.	1	9	fl + L	–					–
51 W.	9	„	fl +	–					–
55 W.	.	„	flaginac +	–					–
50 M.	14	„	fl +	flaginac +	fl +	–			–
57 M.	21	„	fl +	flagac +	–				–
58 W.	22	„	fl + L	–					–
59 M.	5	10	flaginac +	fl(ag) + L	(fl) + L	–			–
60 M.	6	„	flagac +	0 +	–				–
61 W.	7	„	–						–
62 W.	„	„	flag + L	–					–
63 W.	14	„	flag +	(fl)agac +	flag(in)ac +	–			–
64 W.	„	„	flag(in)ac +	flag +	–				–
65 W.	20	„	–						–
66 M.	26	10	flaginac +	(fl) +	0 +	–			–
Biological attributes of the B. coli and coli-like microbes.			18 flaginac 5 flagac 1 (fl) 2 0 1 flag(in)ac 9 fl 1 (fl)(ag) 4 flag 2 flac 1 fl(ag) 1 flinac 1 (fl)agac 2 flagin 1 agin 1 fl(ag)ac 17 Liquefiers	8 flaginac 5 flagac 1 (fl) 2 0 1 fl 1 (fl)(ag) 2 flag 3 flac 1 (ag)ac 2 fl(ag) 1 flinac 1 flagin 1 (in)ac 1 (fl)agac 11 Liquefiers	1 flaginac 1 (fl) 3 0 1 flag(in)ac 3 fl 1 (fl)in 1 (ag)(in) 1 (fl)agac 1 flagin 4 Liquefiers				

N.B.—For explanation of symbols, see text under Tb.

Table IIIc.

...ERIOLOGICAL EXAMINATION of FILTERED WATER as ... the CONSUMERS by WATER COMPANY C.

			Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in :—					Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water
			100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc. / 0·001 cc.	
			F +	0 + L	−			−
			−					
			−					−
			(fl)aginac +	−				−
			flaginac +	F +	fl(in) +			+
			flaginac +	−				−
			flag +	flagac +	−			−
			N S C +	N S C +	fl(ag)ac + L	fl(ag) + L	−	−
			N S C +	(fl)agac + L	(fl)(ag)ac +	−		−
10 W.	8	„	(fl)agac + L	fl(ag)(in)ac +	−			−
11 W.	15	„	F +	flaginac +	−			−
12 W.	22	„	−					−
13 W.	„	„	fl +	(fl) +	(fl)ag + L	−		−
14 W.	13	10	flagac +	flagac +	−			−
15 W.	„	„	flag(in)ac +	flag +	fl +	−		−
16 W.	21	„	(fl) + L	flaginac +	−			−
Biological attributes of the B. coli and coli-like microbes.			2 flaginac 1 flagac 1 (fl) 1 flag(in)ac 1 fl 1 flag 1 (fl)agac 1 (fl)aginac 2 Liquefiers	2 flaginac 2 flgac 1 (fl) 1 0 1 flag 1 (fl)agac 1 fl(ag)(in)ac 2 Liquefiers	1 fl 1 (fl)agiac 1 (fl)ag 1 fl(ag)ac 1 fl(in) 2 Liquefiers	1 (fl)ag 1 Liquefier		

N.B.—For explanation of symbols, see text under I. B.

TABLE IVc.

RESULTS of the BACTERIOLOGICAL EXAMINATION of FILTERED WATER as SUPPLIED to the CONSUMERS by WATER COMPANY D.

Number.	1908. Day.	1908. Month.	Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in :— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
1 W.	1	7	−						−
2 W.	"	"	fi(ag)ac + L	−					−
3 M.	15	"	−						−
4 M.	"	"	flagac + L	−					−
6 M.	"	"	flagac +	−					−
6 W.	6	8	−						−
7 W.	7	9	flaginac +	fi + L	−				−
8 W.	21	"	flaginac +	−					−
9 W.	26	"	flaginac +	flaginac +	−				−
10 W.	27	10	flagin +	flaginac +	−				−
11 W.	"	"	flaginac +	0 + L	flaginac +	−			−
Biological attributes of the B. coli and coli-like microbes.			4 flaginac 2 flagac 1 flagin 1 fi(ag)ac 3 Liquefiers	3 flaginac 1 0 1 fi 2 Liquefiers.	1 flaginac				

N.B.—For explanation of symbols, see text under 1B.

Table Vc.

Results of the Bacteriological Examination of Filtered Water as Supplied to the Consumers by Water Company E.

Number.	1903. Day.	1903. Month.	Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in :— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
1 W.	1	7	N S C +	(f)ac + L	−				−
2 W	"	"	N S O +	agac + LY	f + L	−			−
3 W.	"	"	flac + L	f + L	−				−
4 M.	"	"	flaginac +	(f)aginac + LY	−				−
5 M.	"	"	(f) +	−		−			−
6 M.	"	"	flagin +	−					−
7 M.	"	"	flagac +	(f)ac + L	−				−
8 W.	"	"	−						−
9 W	"	"	−						−
10 W.	12	8	0 + L	−	−				−
11 W.	2	9	f + L	−					−
12 M.	"	"	f + L	−					−
13 W.	23	"	−						−
14 M.	29	"	(f)(in) + L	−					−
Biological attributes of the B. coli and coli-like microbes.			1 flaginac 1 flagac 1 (f) 1 0 2 f 1 flac 1 flagin 1 (f)(in) 5 Liquefiers	1 f 1 (f)aginac 2 (f)ac 1 agac 6 Liquefiers	1 f 1 Liquefier				

N.B.—For explanation of symbols, *see* text under Ib

Table VIc.

Results of the Bacteriological Examination of Filtered Water as Supplied to the Consumers by Water Company F.

Number.	1903. Day.	1903. Month.	Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in :— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
1 M.	15	7	−						−
2 W.	16	"	flagac +	−					−
3 M.	4	8	flin +	ac + L					−
4 W.	17	"	flagin +	−					−
5 W.	24	"	flag +	−					−
6 W.	7	9	−						−
7 M.	14	"	flaginac +	−					−
8 W.	29	"	flin +	fl +	-				−
9 M.	5	10	−						−
10 M.	28	"	flaginac +	flaginac +	-				−
Biological attributes of the B. coli and coli-like microbes.			2 flaginac 1 flagac 1 flag 1 flagin 2 flin	1 flaginac 1 fl 1 ac 1 Liquefier					

N.B.—For explanation of symbols, *see* text under IB.

Table VIIc.

Results of the Bacteriological Examination of Filtered Water as Supplied to the Consumers by Water Company. G.

Number.	1903. Day.	1903. Month.	Presence (+) or absence (−) of B. coli or gas-forming coli-like microbes in:— 100 cc.	10 cc.	1 cc.	0·1 cc.	0·01 cc.	0·001 cc.	Presence (+) or absence (−) of the spores of B. enteritidis sporogenes in 10 cc. of the water.
1 W.	15	7	−						−
2 W.	15	8	fl +	−					−
3 M.	14	9	flagmac +	−					−
4 W.	15	9	−						−
Biological characters of the B. coli and coli-like microbes.			1 flagmac 1 fl						

N.B.—For explanation of symbols, *see* text under Ib.

III.—Analysis of the Results.

(1) *B. enteritidis sporogenes test.*

It is convenient to consider in the first place the results obtained by the use of the B. enteritidis sporogenes test. From this point of view the several waters may be grouped as follows:—

—	Samples examined.	Remarks.
Water Company A.	34	Out of a total of 155 samples only three samples (one sample A., two samples B.) yielded a positive result when 10 cc. were used for cultural purposes. Of these three cultures one was virulent, one non-virulent, and the remaining culture was not tested for pathogenicity. Three other samples yielded a practically negative result.
,, ,, B.	66	
,, ,, C.	16	
,, ,, D.	11	
,, ,, E.	14	
,, ,, F.	10	
,, ,, G.	4	
Total	155	

These results may appear at first sight surprising; but it must be remembered that even crude sewage contains usually not more than from 100 to 1,000 spores of this anærobe per cc., and that the Thames and Lea waters, although unsatisfactory, are fortunately much purer than crude sewage.

For example, out of 33 samples of Thames water collected at Sunbury and Hampton about 6 per cent. yielded, as regards B. enteritidis sporogenes, a negative result when using for cultural purposes 10 cc. of the sample; about 51 per cent. yielded a positive result with 10 cc.; about 39 per cent. a positive result with 1 cc.; and about 3 per cent. a positive result with ·1 cc. So that it was not to be anticipated that the London waters after storage and filtration should yield, unless very exceptionally, a positive result with 10 cc. of the sample.

Nevertheless, negative results have a value of their own; and the tests at all events show that instead of about 40 per cent. (as was to be anticipated if storage and filtration were of negligible value) of the samples yielding a positive result when 10 cc. of the water were used for cultural purposes, the proportion of positive results actually obtained was rather less than 2 per cent. Compared with sewage, 98 per cent. of the filtered water were at least ten thousand to one hundred thousand times purer by this test. Further, in view of stress that has been laid by certain observers

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on an assumed ubiquity of this anaërobe, it may not be amiss to lay emphasis on the fact that out of 155 samples of filtered water only three samples yielded a positive result when 10 cc. of the water were used for cultural purposes.

(2) *B. coli test.*

For purposes of comparison it is desirable to refer once again to the biological condition of the Thames at Sunbury and Hampton. The results thus obtained may be expressed in tabular form as follows:—

TABLE VIIIc.

Number of B. coli (or coli-like microbes).

River Thames at—	At least 1 per cc.	At least 10 per cc.	At least 100 per cc.	At least 1,000 per cc.	Percentage number of coli-like microbes giving both indol in broth culture and acid clot in litmus milk culture.
Sunbury ...	—	70·6 per cent.	23·5 per cent.	5·9 per cent.	64·7 per cent.
Hampton ...	11·8 per cent.	64·7 per cent.	17·7 per cent.	5·9 per cent.	76·5 per cent.

(a) *Total number of coli-like microbes in samples of filtered London water.*

In the first place, the total number of coli-like microbes in the filtered water of each of the water companies will be considered irrespective of the biological attributes of the coli-like microbes. In the sense here employed a coli-like microbe means a microbe, which, when isolated in pure culture by means of secondary gelatine plate cultures made from the primary cultures (which had given both acid and gas), yields, on further subculture, "gas" in gelatine "shake" culture. The results may be expressed in tabular form as follows.

TABLE IXc.

Total number of coli-like microbes.

Number of B. coli or coli-like microbes.	Water Company A.	Water Company B.	Water Company C.	Water Company D.	Water Company E.	Water Company F.	Water Company G.
– 100 cc.	2 out of 34 samples (about 6 per cent.).	10 out of 66 samples (about 15 per cent.).	3 out of 16 samples (about 19 per cent.).	3 out of 11 samples (about 27 per cent.).	3 out of 14 samples (about 21 per cent.).	3 out of 10 samples (about 30 per cent.).	2 out of 4 samples (about 50 per cent.).
+ 100 cc. – 10 cc. at least 1 per 100 cc.	2 out of 34 samples (about 6 per cent.).	23 out of 66 samples (about 34 per cent.).	2 out of 16 samples (about 12 per cent.).	4 out of 11 samples (about 36 per cent.).	6 out of 14 samples (about 42 per cent.).	4 out of 10 samples (about 40 per cent.).	2 out of 4 samples (about 50 per cent.).
+ 10 cc. – 1 cc. at least 1 per 10 cc.	10 out of 34 samples (about 30 per cent.).	21 out of 66 samples (about 31 per cent.).	6 out of 16 samples (about 38 per cent.).	3 out of 11 samples (about 27 per cent.).	4 out of 14 samples (about 29 per cent.).	3 out of 10 samples (about 30 per cent.).	None.
+ 1 cc. – ·1 cc. at least 1 per 1 cc.	18 out of 34 samples (about 54 per cent.).	12 out of 66 samples (about 18 per cent.).	4 out of 16 samples (about 25 per cent.).	1 out of 11 samples (about 9 per cent.).	1 out of 14 samples (about 7 per cent.).	None.	None.
+ 1 cc. – 01 cc. at least 10 per cc.	1 out of 34 samples (about 3 per cent.).	None.	1 out of 16 samples (about 6 per cent.)	None.	None.	None.	None.
+ ·01 cc. – ·001 cc. at least 100 per cc.	1 out of 34 samples (about 3 per cent.).	None.	None.	None.	None.	None.	None.
+ ·001 cc. – ·0001 cc. at least 1000 per cc.	None.	None.	None.	None.	None.	None.	None.

In comparing these results, it must be remembered that as regards some of the filtered waters now in question a limited number only of samples were examined so that some of the percentage figures of this preceding table are of small value.

Subject to this qualification, the order of merit on this basis of comparison would appear somewhat as follows :—

(1) Water Company G.

(2) Water Company F.

(3) Water Company D and (4) Water Company E may be bracketed together with perhaps a slight preference for D.

Similarly (5) Water Company B and (6) Water Company C may be classed together with seemingly a slight preference in favour of B.

(7) Water Company A undoubtedly comes last in the list.

The results indicated in the foregoing table are shown diagramatically (Diagram 1c) as follows.

(b) *Number of typical B. coli, in samples of filtered London water.*

For the purposes of this estimate only the non-liquefying *flaginac* B. coli were regarded as typical B. coli.

The results are shown in the following table.

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TABLE XC.

Number of "flaginac" B. coli.

Number of Non-liquefying "flaginac" B. coli.	Water Company A.*	Water Company B.†	Water Company C.‡	Water Company D.	Water Company E.§	Water Company F.	Water Company G.
− 100 cc. First class water (bacteriologically).	12 out of 29 samples (about 41 per cent.).	41 out of 65 samples (about 63 per cent.).	10 out of 14 samples (about 71 per cent.).	6 out of 11 samples (about 54 per cent.).	11 out of 12 samples (about 91 per cent.).	8 out of 10 samples (about 80 per cent.).	3 out of 4 samples (about 75 per cent.).
+ 100 cc. − 10 cc. Second class water (bacteriologically).	3 out of 29 samples (about 10 per cent.).	16 out of 65 samples (about 24 per cent.).	2 out of 14 samples (about 14 per cent.).	2 out of 11 samples (about 18 per cent.).	1 out of 12 samples (about 8 per cent.).	1 out of 10 samples (about 10 per cent.).	1 out of 4 samples (about 25 per cent.).
+ 10 cc. − 1 cc. Third class water (bacteriologically).	7 out of 29 samples (about 24 per cent.).	7 out of 65 samples (about 18 per cent.).	2 out of 14 samples (about 14 per cent.).	2 out of 11 samples (about 18 per cent.).	None.	1 out of 10 samples (about 10 per cent.).	None.
+ 1 cc. − ·1 cc. Fourth class water (bacteriologically).	6 out of 29 samples (about 20 per cent.).	1 out of 65 samples (about 1·5 per cent.).	None.	1 out of 11 samples (about 9 per cent.).	None.	None.	None.
+ ·1 cc. − ·01 cc. Fifth class water (bacteriologically).	1 out of 29 samples (about 3 per cent.).	None.	None.	None.	None.	None.	None.
+ ·01 cc. − ·001 cc. Sixth class water (bacteriologically).	None.	None.	None.	None.	None.	None.	None.

* Samples 2, 3, 4, 12 and 13 not included in the computation.
‡ Samples 8 and 9 not included in the computation.
† Sample 11 not included in the computation.
§ Samples 1 and 2 not included in the computation.

The difference in these results as compared with those of the previous table (coli-like microbes) is striking. Subject to the qualification that only a few samples of certain of the waters were examined, the order of merit on this other basis of comparison is somewhat as follows:—

(1) Water Company E.

(2) Water Company G.

(3) Water Company F.

(4) Water Company C.

(5) Water Company B.

(6) Water Company D.

(7) Water Company A.

Possibly Water Company E, G and F should be bracketed together, and similarly C, B and D should perhaps be considered in one group.

Judged on the foregoing basis (flaginac B. coli) the various waters are much purer than when coli-like microbes of all sorts are included in the computation. This is a matter which will be dealt with later. Meantime a diagramatic representation (Diagram IIc) of the foregoing results (flaginac B. coli) will be of interest for comparison with the diagram Ic coli-like microbes).

Comp

A ..

B ..

C ..

D ..

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[redacted]

waters.

	Water Company D.	Water Company E.	Water Company F.	Water Company G
		⊙		
⊙	• ⊙⊙	•• •	• • ⊙	
	••• ○⊙	○•• ••••	• ••⊙	•⊙
	○○○	○ ○○○○○○○	○○○○ ○	○

(*a*) and (*b*) were found to correspond;

(c) *Comparison between the number of* (a) *coli-like microbes and* (b) "*flaginac*" *B. coli in samples of filtered London waters.*

In the accompanying diagram (Diagram IIIc.) the number of (*a*) coli-like microbes and (*b*) "flaginac" B. coli are plotted out on the same sheet for facilitating comparisons.

It is to be noted that:—In only about 33 per cent. of the cases did (*a*) and (*b*) correspond. In about 54 per cent. of the cases a complete failure to isolate flaginac microbes was experienced. In about 7 per cent., in about 3 per cent., and in about 1 per cent., the number of flaginac B. coli was found to be ten, one hundred, and one thousand times less numerous respectively than were the coli-like microbes.

These results are striking but not surprising in view of my previous reports on Chichester well waters and other waters.*

---

* It may be questioned seriously whether it is justifiable to ignore completely all reference to coli-like microbes which do not possess attributes arbitrarily assigned to typical B. coli. The placing on record of the biological attributes of coli like microbes as well as of typical B. coli may indeed serve occasionally to explain some of the discrepancies of opinion (more apparent perhaps than real) existing in matters of water supply between the topographist and the bacteriologist. I venture to think that the correlation of bacteriological facts with epidemiological experience can best be achieved by a considerably more detailed statement of results than is at present customary among bacteriologists.

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Water Company G.					
+ 100 cc.	+ 10 cc.	+ 1 cc.	+ ·1 cc.	+ ·01 cc.	Total per cent of each group (approximate).
1	0	0	0	0	31
0	0	0	0	0	13
0	0	0	0	0	·86
0	0	0	0	0	3·4
0	0	0	0	0	·43
0	0	0	0	0	5·6
0	0	0	0	0	3
1	0	0	0	0	11
0	0	0	0	0	1·3
0	0	0	0	0	4·7
0	0	0	0	0	·43
0	0	0	0	0	3
0	0	0	0	0	·86
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	·96
0	0	0	0	0	2
0	0	0	0	0	·86
0	0	0	0	0	1·3
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	2
0	0	0	0	0	3
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	1·3
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	·86
0	0	0	0	0	·43
0	0	0	0	0	·86
0	0	0	0	0	·86
0	0	0	0	0	·43
0	0	0	0	0	·45

(d) *Grouping of the B. coli and coli-like microbes of samples of filtered London waters according to their biological attributes.*

At the bottom of each of the preceding tables (Ic to VIIc) a short summary of the biological attributes of the coli-like microbes has been given. It is desirable at this stage to group these results together in order to form an idea of the number of groups, and the percentage number of microbes belonging to each separate group.

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Water Company G.					Total per cent of each group (approximate).
1 cc.	+ 10 cc.	+ 1 cc.	+ ·1 cc.	+ ·01 cc.	
1	0	0	0	0	31
0	0	0	0	0	13
0	0	0	0	0	·86
0	0	0	0	0	3·4
0	0	0	0	0	·43
0	0	0	0	0	5·6
0	0	0	0	0	3
1	0	0	0	0	11
0	0	0	0	0	1·3
0	0	0	0	0	4·7
0	0	0	0	0	·43
0	0	0	0	0	3
0	0	0	0	0	·86
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	·96
0	0	0	0	0	2
0	0	0	0	0	·86
0	0	0	0	0	1·3
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	2
0	0	0	0	0	3
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	1·3
0	0	0	0	0	·43
0	0	0	0	0	·43
0	0	0	0	0	·86
0	0	0	0	0	·43
0	0	0	0	0	·86
0	0	0	0	0	·86
0	0	0	0	0	·43
0	0	0	0	0	·45

It appears from the foregoing table that, even if the question of liquefaction be considered separately, the B. coli and coli-like microbes fall under no less than 35 groups. Only 31 per cent. of the microbes were "flaginac" B. coli. It is not suggested that 35 different species of B. coli were isolated. Many of the groups differ so slightly from each other in their biological characters that it may seem arbitrary to separate them. Nevertheless, it is desirable to emphasize the point in passing that this variability of attribute of their contained B. coli may go far to explain the seemingly innocuous character of the London filtered waters notwithstanding the constant passage of coli-like microbes through the filters. The question of absence or loss of attribute, and the degree of response to positive tests, in relation to differentiation and classification among the B. coli or coli-like tribe of bacteria involves considerations of great complexity. Are aberrant coli-like microbes the progeny of "flaginac" microbes—*i.e.* of typical B. coli—altered by their environment, or are they microbes of separate species altogether, which under certain conditions come to the front and gradually oust the typical B. coli? It seems certain that in fresh human fæces the typical B. coli altogether outnumber the atypical forms. But if fæces were mixed with sterile water and kept for some time certain eventualities are conceivable. Thus the curve representative of the typical B. coli would certainly start at a high figure and would probably at first rise even higher; later it would doubtless fall gradually to a low figure and would eventually reach zero. On the other hand the curve representative of the coli-like microbes might be expected to start low down the scale, then probably it would rise to a considerable height, and afterwards perhaps fall much more slowly than the typical B. coli curve. In this way a time might arrive when the initial relation of the two curves would be reversed; and in such a case the atypical B. coli would eventually exceed in number the typical B. coli. It is also, however, possible that the originally typical B. coli through loss of properties originally possessed by them, might desert, as it were, their ranks and join and swell those of the originally atypical B. coli.

Certainly the proportion of typical B. coli to coli-like microbes in fresh human fæces is remarkably high. In sewage and in sewage effluents this percentage falls a little. But in waters known to be sewage polluted the percentage often drops to a strikingly low figure. How small may be the ratio of typical B. coli to coli-like microbes in the case of polluted waters, after these have been stored and filtered, has just been shown. Unfortunately however in the case of water there may be present, in addition to B. coli and coli-like microbes derived from the human intestine, like micro-organisms voided by lower animals and perhaps also coli-like bacteria derived from the vegetable world; some of them saprophytes bearing remote resemblance to B. coli and possessing moreover capacity for persisting in water for an indefinite period.

The facts at all events are plain, namely, that the filtered London waters nearly always contain B. coli or coli-like microbes; but

that about two-thirds of these coli-like microbes fail to a gre or less extent to conform to the arbitrary "flaginac" standa Moreover, about 29 per cent. of the coli-like microbes isol by me from filtered water slowly liquefied the gelatine Ab 3 per cent. of these liquefiers produced yellow colouration of gelatine medium. Dr. MacConkey has usefully called attenti to this class of glucose (and usually lactose also) fermenti chromogenic coli-like microbes. In another research, of 100 c like microbes isolated from fresh human faeces none liquef gelatine.

Lest the previous grouping of the coli-like microbes be judg to be unnecessarily refined, the following alternative classificati is noted. Here the feebly positive results are taken arbitrar as completely positive; that is, the letters in brackets are absol from the "bracket qualification" which it will be remembe implied a weakness of the attribute concerned.

In this way the 35 groups are reduced to 15, by amalgamati of them as follows :—

Number.	Groups.	——	Per cent.
			About
(1)	1, 7, 29, 30	flaginac	35
(2)	2, 16, 23, 27	flagac	17
(3)	8, 12, 33	flac	5
(4)	4, 8	il	14
(5)	5, 11	ag...	1
(6)	6	0	5
(7)	9, 10, 17, 18	flag	9
(8)	13, 34	agac	1
(9)	14, 24	flagin	3
(10)	15, 19	flinac	2
(11)	20	aginac	·48
(12)	21, 28, 32, 35	flin	2
(13)	22, 26	agin	1
(14)	25	inac	·43
(15)	31	ac	·43

It is further a matter of interest as regards the above filter waters to compare the percentage of B. coli or coli-like microb observed to yield both acid clot in milk culture and indol in bro culture with like data obtained respecting the raw river water unbury and Hampton, above the intake of the water compani

In the filtered waters under discussion this percentage was about 38 per cent., whereas, for samples of water from the Thames at Sunbury and Hampton it was about 65 per cent. and 76 per cent. respectively. In sewage and in sewage effluents the percentage in question will depend largely on the kind of sewage—*e.g.*, the relative proportions of domestic sewage, slop-water, and trade refuse; but, judging from my observations, about 65 per cent. to 85 per cent. of the coli-like microbes of sewage and of effluent produce indol and clot milk. In fresh human fæces about 90 per cent. of the B. coli yield a positive result with both tests.

I cannot directly contrast the "flaginac" microbes—*i.e.*, completely typical B. coli—in the filtered waters with those in the raw Thames water, because in the latter case the neutral red broth and lactose peptone tests were not applied. But whereas in the filtered waters the proportion is about 38 per cent. in fresh human fæces the percentage is as high as about 85 per cent.

Comparing in this sense the reaction to several tests of B. coli of the materials under notice, the following striking differences are manifest:—

Coli-like microbes from—	(Fluorescence in neutral red broth culture.)	(Acid and gas in lactose peptone culture.)	(Indol in broth culture.)	(Acid clot in milk culture.)
London filtered waters.	About 87 per cent.	About 67 per cent.	About 44 per cent.	About 61 per cent.*
Raw Thames water at Sunbury and Hampton.	—	—	77 per cent.	83 per cent.
Fresh human fæces.†	98 per cent.	92 per cent.‡	98 per cent.	92 per cent.
Sewage and sewage effluents.§	85–95 per cent.	85–95 per cent.	65–85 per cent.	80-90 per cent.

* In the case of the London filtered waters the proportion would be still lower for all these tests if "feebly positive" results had not in this comparison been classed as completely positive. Moreover, the percentage is based on the total number of coli-like microbes isolated from the various dilutions or cultures, and not on those occurring in the last dilution or culture in each case yielding coli-like microbes.

† No doubt much depends on age, diet, &c.

‡ In Division I. of this report it is shown that out of 257 coli-like microbes isolated from 12 normal stools, 251 (over 97 per cent.) produced acid and gas in lactose peptone cultures.

§ The kind of sewage influences the results materially.

There can be no question then as to the coli-like microbes of the London filtered waters being far less "typical" than the B. coli of human fæces, of sewages, of effluents, and even of the raw Thames water. Whether this difference be due to "loss of attribute" of

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originally typical B. coli, or to the ascendancy of atypical coli-like microbes under the conditions associated with the storage and filtration of such waters, or whether both possible causes operate to produce it, remains for the present a matter for conjecture. But in whatever way brought about the observed difference is to the credit of filtered London water, in that such water tends, in the processes to which it is subjected, to part with an undesirable biological element which is characteristic of fæcal matter.* On the other hand, however, the fact remains that about one-third of the coli-like microbes in filtered London water were non-liquefying "flaginac" microbes; that indeed disappearance of these undesirale micro-organisms was observed to be relative, not absolute.

(e) *Comparison of the primâ facie† test and the number of B. coli or coli-like microbes actually isolated from the various filtered waters.*

A comparison has been made already between the number of (*a*) coli-like microbes and (*b*) "flaginac" B. coli. It is of interest also to contrast the number of coli-like microbes‡ actually isolated from the filtered waters with the presumptive evidence of their presence which had been based on the occurrence of gaseous fermentation of the primary medium.

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* I am anxious to make my meaning clear by an illustration. A raw water contains 100 coli-like microbes per cc. of which 66 ($\frac{2}{3}$) are typical B. coli.

The collective effect of storage and filtration is to reduce the coli-like microbes to 3 per cc., and to reduce the proportion of typical B. coli (by natural processes which I will call ×) from $\frac{2}{3}$ to $\frac{1}{3}$. Hence the water after storage and filtration contains one typical B. coli per cc. On this basis of computation it might be considered that the same effect would be produced by ingesting 66 cc. of the stored and filtered water as by drinking one cc. of the raw water, since in both cases the same number of typical B. coli would be drunk. But it is not unlikely that × is less a mechanical than a selective biological process, and that it may have accomplished more than the foregoing figures suggest. For example, it may be that when × process is so effective as to reduce the typical B. coli from $\frac{2}{3}$ to $\frac{1}{3}$, survival of pathogenic microbes less abundant originally, and far less hardy always, than B. coli is practically out of question.

† By the *primâ facie test* is meant the occurrence of gaseous fermentation of the bile-salt glucose peptone primary medium.

‡ In the sense here indicated a coli-like microbe is a micro organism isolated in pure culture from the primary bile-salt medium by means of secondary plate cultures, and which resembles more or less closely typical B. coli, while yielding, apart from other tests, "gas" in "gelatine shake" cultures.

-like microbes actually isolated by means of

Water Company D.	Water Company E.	Water Company F.	Water Company G.

the primary cultures.

spond.

It will be seen from the table that there is much less divergence between the *primâ facie* test (*i.e.*, gaseous fermentation of the primary medium) and the number of coli-like microbes actually isolated (by means of secondary plate cultures from the primary cultures) than between the number of coli-like microbes thus isolated and the number of "flaginac" B. coli definitely ascertained to be present. Moreover, it needs to be remembered that failure to isolate, by subculture coli-like microbes from the primary cultures showing *primâ facie* evidence of the presence of these micro-organisms affords relative rather than absolute proof of their absence. The rapid development, for example, in the primary medium of liquefying species may, if the initial number of coli-like microbes has been small, render it difficult to isolate coli-like microbes from the secondary plate cultures.

The *primâ facie* test is seldom at fault when dealing with fæces, sewage, sewage effluents, and obviously polluted waters. Unfortunately, however, it is not in the case of materials such as these that the question of the presence of B. coli or of coli-like microbes is in doubt.* In all doubtful cases of water pollution it may be advisable to state the results of the *primâ facie* test, but it is essential to supplement this presumptive knowledge by isolation in pure culture of the coli-like microbes and further to study in detail their biological attributes.

IV. Summary and Conclusions.

In the foregoing pages the results of the bacteriological analysis of 155 samples of London filtered waters have been considered in detail.

As regards the *B. enteritidis sporogenes test*, only three out of the 155 samples yielded a positive result when using 10 cc. of the filtered water for cultural purposes.

The *B. coli test* yielded results as follows.

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* In all important cases, and for instance when water supply is in question, the *primâ facie* test must needs be held of subordinate value. In such cases the responsible bacteriologist will naturally not rely solely on presumptive evidence of dangerous pollution, but will leave no final tests untried which may serve to elucidate the facts. I would not however be misunderstood as disparaging presumptive tests generally; and indeed I believe that no presumptive test for B. coli at present in vogue excels, if indeed any can be said to equal in value the bile-salt glucose peptone test of MacConkey. In its negative aspects the test remains unrivalled.

TABLE .

B. coli tests.

Number of B. coli and coli-like microbes.*	Water Company A.		Water Company B.		Water Company C.		Water Company D.		Water Company E.		Water Company F.		Water Company G.	
	Coli-like microbes.	Flaginac B. coli.	Coli like microbes.	Flaginac B. coli.	Coli-like microbes.	Flaginac B. coli.	Coli-like microbes.	Flaginac B. coli.	Coli-like microbes.	Flaginac B. coli.	Coli like microbes.	Flaginac B. coli.	Coli-like microbes.	Flaginac B. coli.
− 100 cc.	Per cent. 6	Per cent. 41	Per cent. 16	Per cent. 63	Per cent. 19	Per cent. 71	Per cent. 27	Per cent. 54	Per cent. 21	Per cent. 91	Per cent. 50	Per cent. 80	Per cent. 50	Per cent. 75
+ 100 cc. − 10 cc. At least 1 per 100 cc.	6	10	34	24	12	14	36	18	42	9	40	10	50	25
+ 10 cc. − 1 cc. At least 1 per 10 cc.	30	24	51	10	38	14	27	18	29	None.	30	10	None.	None
†														
− 1 cc + ·1 cc. At least 1 per 1 cc.	54	30	18	1·5	25	None.	9	9	7	None.	None.	None.	None.	None
+ ·1 cc. − ·01 cc. At least 10 per cc.	3	3	None.	None.	6	None.	None.	None.	None.	None.	None.	None.	None.	None.
− ·01 cc. + ·001 cc. At least 100 per cc.	3	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.
+ ·001 cc. − ·0001 cc. At least 1000 per cc.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.

* The percentages are only approximate and must be interpreted according to the important qualification that only a very few samples of certain of the Water Companies were examined.

† The horizontal double line refers to a provisional standard. All samples below this line are open to objection.

Speaking of the waters individually, the A water proved the least satisfactory. Possibly B, C, and D waters should be grouped together. The best water, according to my results, was supplied by E, F, and G companies.

Dealing with the filtered water samples collectively the following points are to be noted :—

——		Coli-like microbes.	"Flaginac" B. coli.
*A water of the first class	absent in 100 cc.	24 per cent. of 155 samples.	68 per cent. of 155 samples.
A water of the second class	... + 100 cc. / — 10 cc.	About 33 per cent. of 155 samples.	About 15 per cent. of 155 samples.
A water of the third class	... + 10 cc. / — 1 cc.	About 26 per cent. of 155 samples.	About 11 per cent. of 155 samples.
†			
A water of the fourth class	... + 1 cc. / — ·1 cc.	About 16 per cent. of 155 samples.	4 per cent. of 155 samples.
A water of the fifth class	... + ·1 cc. / — ·01 cc.	1·3 per cent. of 155 samples	0·4 per cent. of 155 samples.
A water of the sixth class	... + ·01 cc. / — ·001 cc.	0·4 per cent. of 155 samples.	0
A water of the seventh class	... + ·001 cc. / — ·0001 cc.	0	0

* This division of waters into classes was suggested in my last year's report.
† The horizontal line refers to a provisional standard. Waters below this line would by it be objected to.

Broadly speaking, about three-quarters of the 155 water samples contained coli-like microbes in either 100 cc., 10 cc., or 1 cc.

About one-third of the samples contained "flaginac"—*i.e.*, typical—B. coli either in 100 cc., 10 cc., or 1 cc.

Taking into account coli-like microbes of all sorts about 24, 33, 26, 16, 1·3 and 0·4 per cent. of the 155 water samples come under the first, second, third, fourth, fifth and sixth classes respectively. About 18 per cent. of the 155 would be considered unsatisfactory according to the suggested standard.

Ignoring all coli-like microbes other than "flaginac" B. coli, about 68, 15, 11, 4 and 0·4 per cent. of the 155 water samples come

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under the first, second, third, fourth, and fifth classes respectively. Less than 5 per cent. of the 155 would be objected to on the provisional 1 cc. standard (*see* foregoing Table).

Comparing (*a*) the coli-like microbes and (*b*) the "flaginac" (typical) B. coli it is noteworthy that:—

In only about 33 per cent. of the samples did (*a*) the coli-like microbes and (*b*) the "flaginac" B. coli correspond. In about 54 per cent. of the samples a complete failure to isolate "flaginac" microbes was experienced. In about 7 per cent., 3 per cent., and 1 per cent. of the samples the number of "flaginac" B. coli was respectively ten, one hundred, and one thousand times less than the number of coli-like microbes (*see* III.) (2) (*c*).

As regards classification of the biological attributes (on the basis of the tests employed) of the 232 B. coli or coli-like microbes isolated from the several filtered water samples:—

If feeble response to one or more positive tests be taken into account in the classification, the number of separate groups is 35 and the percentage of "flaginac" B. coli about 31.

If a broader view be taken and feebly positive results be regarded as completely positive, the number of separate groups is 15 and the percentage of "flaginac" B. coli about 35.

But whatever view be taken, it is obvious that the filtered waters contained coli-like microbes presenting in their attributes nearly every conceivable variation from typical B. coli to microbes so atypical as scarcely to merit inclusion in the coli group of bacteria.

In the text of this report, here pointed out, in as impartial a spirit as I can command and on as broad a basis as my personal experience allows, that the percentage of coli-like microbes showing "weakness of attribute" or "loss of attribute" in the London filtered waters is *far in excess* of what is found on the bacteriological examination of normal human fæces, sewages, sewage effluents, or even sewage polluted river waters (*e.g.*, the raw Thames water at Hampton and Sunbury).

In bringing this report to a conclusion, I would note certain circumstances which from my point of view are of particular interest in connexion with the experience, that the enteric fever death-rate in the metropolis has been low over a long term of years, notwithstanding the fact that the *main sources* of London water supply are from rivers (Thames and Lea) admittedly sewage polluted.*

In this connection the following observations may be made:— In the first place it is to be noted that many of the sources of

* On one point and one only I would especially insist: Namely on the danger of arguing from the particular case of London and its apparent immunity from water-borne disease to public water supplies in general. The assumption, that a sewage polluted water may after storage and filtration be drunk with absolute immunity from risk, is not one, that should be readily entertained, even though the conditions *seem* to run broadly parallel with those pertaining to the London water supply.

contamination of the Rivers Thames and Lea are situated some distance above the intakes of the London waterworks,

Secondly, that the towns bordering on the Rivers Thames and Lea which discharge their sewage into these respective rivers have not, it is believed, suffered for many years to a notable extent from enteric fever.

Thirdly, that of the B. coli, actually isolated from the Rivers Thames and Lea waters above the intakes of the water companies not all are typical; and that of those that are typical, some are possibly not of human fæcal origin. (Nevertheless, the percentage number of typical B. coli in these river waters is undoubtedly high and there is not sufficient reason for regarding the majority of these as derived from sources other than the human intestine.)

Fourthly, that although there may be ground for regarding the number of typical B. coli in a water as strictly proportional to the degree of potential danger to health, it must not be forgotten that the presence of even typical B. coli is no absolute proof that B. typhosus would, if also present originally, have remained viable under parallel conditions.

Fifthly, that the raw London waters are commonly stored for a long time before being filtered, and that "delay" of this kind in transferring water from a river to the consumer might conceivably act not only mechanically and extrinsically but also so as to produce modification of the originally objectionable biological attributes of the crude waters. A number of facts in my possession seem to support this hypothesis.

Sixthly, that these river waters after prolonged storage are subjected to a careful process of sand filtration. This is a mechanical, possibly also a bio-mechanical, safeguard of acknowledged value.

Seventhly, that it has been shown conclusively that the coli-like microbes of these filtered waters are *far less typical* than the coli-like microbes of human fæces, of sewage effluents, or even of the raw Thames water. Moreover, that 24 per cent. of the samples contained no coli-like microbes of any sort, and 68 per cent. no "flaginac" B. coli even when using 100 cc. of the water for cultural purposes.

Eighthly, that only about 18 per cent. of the samples contained coli-like microbes, and less than 5 per cent. "flaginac" B. coli in 1 cc. or less of these filtered waters. Hence, according to a provisional standard of a negative result with 1 cc., only 18 per cent. and less than 5 per cent. respectively of the samples were liable to be rejected by the B. coli test.

In the foregoing pages it has been my endeavour to give an unbiassed account of the biological qualities of London filtered waters during the summer and autumn of 1903, and to correlate the bacteriological facts with existing epidemiological knowledge as regards the comparatively low incidence of enteric fever in the Metropolis. That the facts which I have recorded, being judicially interpreted, help to explain the relative immunity from water-

borne disease enjoyed by the inhabitants of London will not, I think be denied. The matter is indeed one of general importance. For if the bacteriologist pays regard mainly to evidence against the London filtered waters while neglecting facts telling in their favour, as for instance epidemiological data as to absence of water-borne disease, the judicial minded perusers of his representations might be apt to discredit the practical value of bacteriological tests of water as evidence of its danger to health.

Nevertheless, I desire to make it quite clear that I still regard storage and filtration of a sewage polluted water as a relative not an absolute safeguard, if such water is to be utilised for drinking purposes.* It is to be remembered that, despite the atypical character of the majority of the coli-like microbes isolated by me from the various filtered waters, about one-third of the samples contained "flaginac" B. coli in 100, in 10 or in 1 cc. An impartial interpretation of the results of the B. coli test both from the qualitative and quantitative points of view tends, I consider, partially, but not wholly, to the withholding from the London filtered waters *bacteriological objection*.† What I ventured to state, in reference to B. coli, as regards potential danger to health in my report on this subject to the Royal Commission on Sewage Disposal‡ is still my view, and is, moreover, not inconsistent with the line of reasoning adopted in the present report.

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* The Hamburg cholera epidemic of 1892 is often quoted erroneously as proving that filtration is an absolute safeguard. The facts briefly were these:—Hamburg and Altona derived their water supply from the Elbe. The Hamburg intake was situated above the city, the Altona intake below Hamburg and its sewage outfalls. The Hamburg water was thus initially much purer than the Altona water, but the former water was delivered to the consumers in the raw condition, whereas, the latter was first carefully filtered. Hamburg was grievously stricken with cholera. Altona at first escaped relatively speaking. Later, however, cholera suddenly broke out in Altona and a searching investigation revealed the fact that coincidently a serious breakdown in the filtering arrangements had occurred. These experiences have led sanitarians to consider the Hamburg-Altona outbreak as affording the strongest presumptive evidence that filtration is a relative not an absolute safeguard.

† The italics here are used advisedly. The bacteriologist can do no more than utilise existing knowledge. There are many factors in relation to the dissemination of disease which lie beyond his ken. It is desirable perhaps that he should rely largely on his facts and shun the epidemiological arena. Yet the correlation of topographical observations, epidemiological considerations, and bacteriological facts is essential if trustworthy conclusions are to be arrived at.

‡ Royal Commission on Sewage Disposal Fourth Report. Vol. III.

APPENDIX C.

FURTHER OBSERVATIONS on CHLOROFORMED CALF VACCINE ;* by DR. ALAN B. GREEN.

During the past year a considerable number of vaccines have been treated by the chloroform process, and these, after passing the usual tests, have been issued for general vaccination purposes.

In addition some further points in connection with the chloroform process have been investigated, and it will be convenient in the first place to give an account of these investigations, especially as they affect to some extent the preparation of vaccine by means of chloroform.

The Effect of Temperature in the Elimination of Extraneous Micro-organisms by the Chloroform Process.

It was noticed in carrying out the chloroform process in a room, the temperature of which was necessarily variable, that the rate of elimination of extraneous micro-organisms from vaccine emulsion varied approximately with the variations of that temperature. It was especially evident that in the winter when the room temperature might be as low as 10° C., the germicidal action was much slower than in the summer when the room temperature might be 25° C. or higher. Chloroform thus apparently acted in conformity with other germicidal agents, its germicidal action varying in degree at different temperatures. It was thought desirable, however, to determine the germicidal action of chloroform at different temperatures with greater accuracy than was possible by carrying out the process in a room the temperature of which was variable. For these experiments it was necessary to alter in some slight degree the chloroform apparatus described in my last paper.† As modified the apparatus consisted of a cotton wool air filter, a gas washing bottle partly filled with pure liquid chloroform, an overflow bottle for the chloroform, and a tube or tubes of test tube shape to contain the emulsion. These several component parts were described in detail in my last paper. The remainder of the apparatus there described was in the present arrangement omitted. The parts were connected by means of indiarubber tubing, as was the *outlet* of the

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The Effect of Temperature in the Elimination of Extraneous Micro-organisms by the Chloroform Process.

It was noticed in carrying out the chloroform process in a room, the temperature of which was necessarily variable, that the rate of elimination of extraneous micro-organisms from vaccine emulsion varied approximately with the variations of that temperature. It was especially evident that in the winter when the room temperature might be as low as 10° C., the germicidal action was much slower than in the summer when the room temperature might be 25° C. or higher. Chloroform thus apparently acted in conformity with other germicidal agents, its germicidal action varying in degree at different temperatures. It was thought desirable, however, to determine the germicidal action of chloroform at different temperatures with greater accuracy than was possible by carrying out the process in a room the temperature of which was variable. For these experiments it was necessary to alter in some slight degree the chloroform apparatus described in my last paper.† As modified the apparatus consisted of a cotton wool air filter, a gas washing bottle partly filled with pure liquid chloroform, an overflow bottle for the chloroform, and a tube or tubes of test tube shape to contain the emulsion. These several component parts were described in detail in my last paper. The remainder of the apparatus there described was in the present arrangement omitted. The parts were connected by means of indiarubber tubing, as was the *outlet* of the

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APPENDIX C.

Further observations on Chloroformed Calf Vaccine; by Dr. Green.

emulsion tube with a filter pump, in such a way that, the *exhaust* of the filter pump being used, air was drawn in the first instance through the cotton wool air filter, then into the long tube of the gas washing bottle and through the liquid chloroform which it contained, whereby it became admixed with chloroform vapour. This mixture of chloroform vapour and air was next passed through the overflow bottle and down the long tube of the emulsion tube. The mixture was next passed through the emulsion contained in this tube and escaping thence through the short outlet was carried away to the filter pump. The passage of air and chloroform through the emulsion was regulated by means of a clamp placed on the indiarubber tubing attached to the outlet of the emulsion tube.

For each of the following experiments a complete apparatus as described above was placed in an enclosed space, generally in a Hearson's incubator which was constantly of the temperature required for the experiment. Thus, only a mixture of air and chloroform vapour of the temperature required for the experiment was passed through the experimental emulsions.

The experiments were as follows.

SERIES 1.

In the first instance experiments were made with beef broth emulsions of *S. aureus* and *S. albus*. Sets of apparatus, as described above, were placed in incubators, one set being placed at 37° C., one at 30° C., one at 25° C., one at 20°C., one at 15° C., and one at 10° C. In the emulsion tube of each set of apparatus were placed 10 c.c. of beef broth emulsion of the micro-organism to be experimented with, and the tube of emulsion, together with the remainder of each respective set of apparatus, was then allowed to stand for one hour at the temperature of the experiment in order that it might gain that temperature before the passage through it of chloroform vapour and air was begun. The passage of chloroform vapour and air was then started and was continued in some instances for six hours. When the passage was discontinued, the entrance and exit of each emulsion tube were clamped in order to prevent the escape of any chloroform from the tube, and each tube was stored for 66 hours further at the temperature at which it had been subjected to the passage of chloroform vapour and air.

The number of micro-organisms present in the emulsion was ascertained, both immediately before beginning the passage of chloroform vapour and air, and at subsequent intervals during the passage and after it had been stopped. This estimation of numbers was made by inoculating tubes of liquefied nutrient agar-agar with one platinum loopful of broth emulsion and establishing plates in the usual way. The plates were incubated for 48 hours at 37° C., and for 72 hours further at 20° C. Eight experiments were made with *S. aureus*, and six experiments with *S. albus*, and the averages of the results appear in the following Table 1.

Table 1.

Time of Inoculating Nutrient Agar-agar and pouring plates.	Average of Eight Experiments with *S. aureus*. Number of Micro-organisms present per platinum loopful of Emulsion at various temperatures.						Average of Six Experiments with *S. albus*. Number of Micro-organisms present per platinum loopful of Emulsion at various temperatures					
	10° C.	15° C.	20° C.	25° C.	30° C.	37° C.	10° C.	15° C.	20° C.	25° C.	30° C.	37° C.
Immediately before passage of air and chloroform vapour.	4,000	-	—	—	—		7,000	—	—	—	—	—
Half an hour after beginning passage of air and chloroform vapour.	—	3,800	3,200	1,900	172	20		6,200	5,400	5,000	3,000	94
One hour after beginning passage of air and chloroform vapour.	—	2,800	1,1[illegible]	100	12	0	—	5,700	3,200	1,100	819	7
Two hours after beginning passage of air and chloroform vapour.	—	2,400	600	64	0	0	—	5,800	980	85	48	0
Three hours after beginning passage of air and chloroform vapour.	—	1,200	180	11	0	0	—	3,100	28	5	0	0
Six hours after beginning passage of air and chloroform vapour.	—	340	0	0	0	0	-	1,900	0	0	0	0
Eighteen hours after passage of air and chloroform vapour had ceased.	2,400	118	0	0	0	0	5,100	740	0	0	0	0
Sixty-six hours after passage of air and chloroform vapour had ceased.	1,200	20	0	0	0	0	2,300	24	0	0	0	0

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It will be seen from the foregoing table that the rate of germicidal action varied directly with the temperature at which the broth emulsions of the micro-organisms were subjected to chloroform, the germicidal action being strongest at the highest temperature and weakest at the lowest.

SERIES 2.

In the second series of experiments, six vaccine emulsions were subjected to the chloroform process in a manner similar to that used for the beef broth emulsions of the preceding series. Each vaccine emulsion consisted of one part by weight of crude vaccine pulp freshly collected from the calf, and two parts by weight of sterile distilled water. This, after mixture, was divided into six equal portions, and each portion was placed in a separate emulsion tube, one portion being placed at 37° C., one at 30° C., one at 25° C., one at 20° C., one at 15° C., and one at 10° C. After each emulsion had gained the temperature of the experiment, the passage of chloroform vapour and air through it was begun and lasted for six hours. At the end of the six hours the entrance and exit of each emulsion tube were clamped, and each tube was then stored for 66 hours further at the temperature at which it had been subjected to the passage of chloroform vapour and air. At the expiration of the 66 hours the chloroform was partially removed from each emulsion which was then stored at 10° C. A bacteriological examination, exactly similar to that of the preceding Series 1, was made of each emulsion just before beginning the passage of chloroform vapour and air. It was found that the extraneous bacteria present were practically limited to *S. aureus* and *S. albus*; of the few other micro-organisms present no note was taken. Further examinations were made of each emulsion at the end of one, two, three, and six hours after beginning the passage of chloroform vapour and air, and 66 hours after the passage of air and chloroform vapour had ceased. The results of these examinations appear in the following Table 2.

TABLE 2.

Average of Six Experiments with Vaccine Emulsion containing *S. aureus* and *S. albus*.

Time of Inoculating Nutrient Agar-agar and pouring plates.	Number of Micro-organisms present per platinum loopful of Emulsion at various temperatures.					
	10° C.	15° C.	20° C.	25° C.	30° C.	37° C.
Immediately before passage of air and chloroform vapour.	16,000	—	—	—	—	—
One hour after beginning passage of air and chloroform vapour.	—	9,800	4,800	2,700	640	14
Two hours after beginning passage of air and chloroform vapour.	—	6,000	1,200	900	23	0
Three hours after beginning passage of air and chloroform vapour.	—	4,000	200	15	2	0
Six hours after beginning passage of air and chloroform vapour	—	1,900	0	0	0	0
Sixty-six hours after the passage of air and chloroform vapour had ceased.	6,000	38	0	0	0	0

It will be seen that a definite germicidal action was evidenced on the extraneous micro-organisms of these vaccine emulsions, and that this germicidal action was more rapid at the higher temperatures than at the lower. The germicidal action in fact corresponded closely with that exhibited in the experiment with the beef broth emulsions of the preceding Series 1.

Having ascertained in some degree the influence at various temperatures of the chloroform process on these extraneous micro-organisms of calf vaccine, it was necessary to investigate the action of chloroform at these temperatures on the specific germ of vaccine.

Accordingly a portion of each of the foregoing vaccine emulsions was inoculated on a calf. As previously stated, each of these emulsions was subjected to the passage of chloroform vapour and air at one or another temperature for six hours, and had been kept at that temperature for 66 hours further with the exit and entrance tube clamped to prevent the escape of any of the chloroform from the emulsion tube. At the end of the 66 hours the chloroform present was partially removed by means of a stream of sterile air and each emulsion was then stored at 10° C.

The inoculations of these vaccines on calves varied somewhat in the intervals which elapsed after their treatment with chloroform had ceased and their storage in the presence of a small amount of chloroform at 10° C. had begun. But the difference in the intervals amounted in no case to a longer period than one week, so that a portion of each vaccine was inoculated on a calf at an interval of between three and four weeks after the storage had begun.

The vesicles resulting from these inoculations differed in quality. Differences of appearance of vaccine vesicles on calves have been commented on by Dr. Blaxall.* Observations of varieties of vesicles yielded by a large number of calves, together with knowledge of the results of the use for general vaccination purposes of the vaccine obtained from those vesicles, can enable an observer to form a very close estimate of the value of diverse calf vesicles for general vaccination purposes.

In the case in question, a difference was chiefly apparent between those vesicles resulting from the use on the one hand of emulsions chloroformed at 10° C., 15° C., and 20° C., and on the other hand from vesicles resulting from the use of emulsions chloroformed at 37° C. The former vesicles were of good quality, while the latter exhibited, comparatively, inferiority. The vesicles resulting from the use of those portions of emulsion chloroformed at 25° C. and 30° C. varied, but in the greater number of cases they did not appear to be of such good quality as those vesicles resulting from the use of emulsions chloroformed at 10° C., 15° C., and 20° C. As a whole the experiments indicated that those emulsions which were chloroformed at 25° C., 30° C., and 37° C. had suffered loss of potency compared with the emulsions chloroformed at 10° C., 15° C., and 20° C.

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* British Medical Journal, July 5th, 1903, p. 38

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In the foregoing series of experiments in which the six parts of each emulsion were exposed at different temperatures the amount of chloroform present in these parts could not have been quite the same. For, owing to the differences in temperature, the proportions of air and chloroform vapour would have been different, and the solubility of chloroform in the water of the emulsions would have differed also.

To eliminate this varying factor—the varying amounts of chloroform in the parts of the emulsion—and to ascertain how far the difference in degree of germicidal action might be due solely to difference in temperature when the amount of chloroform in all six parts of the emulsion was constant, a third series of experiments was undertaken.

Series 3.

Vaccine emulsion was prepared as before (Series 2), consisting of one part by weight of freshly collected crude calf vaccine and two parts by weight of sterile distilled water. This emulsion was divided into six equal portions each portion being placed in a separate emulsion tube. These six tubes of emulsion were next placed at 15° C. and, with their respective sets of apparatus, were allowed to stand at this temperature for from one to two hours in order that they might in their entirety reach this temperature. The passage of chloroform vapour and air was next begun through each emulsion at the same temperature (15° C.), in the manner described in the two foregoing series, and approximately at the same rate. Thus, chloroform vapour and air of the temperature of the experiment was passed through each of the six tubes of vaccine emulsion each of which had been brought to the same temperature. After this passage had been continued for half an hour, the entrance and exit of each emulsion tube were clamped in order that none of the contained chloroform should escape, and one tube of emulsion was placed at each of the following six temperatures :— 10° C., 15° C., 20° C., 25° C., 30° C., and 37°C.

These emulsions, during the process of being chloroformed, must each have received practically the same amount of chloroform, and each with virtually equal amounts of chloroform in solution, was then removed to one of the six temperatures above mentioned, and under such influence was stored for 72 hours. Subsequently each tube of emulsion was removed to the ice chest at 10° C.

A bacteriological examination of the emulsion in each tube was made by the method described in the two preceding series of experiments. The emulsions were examined as follows :— (*a*) the emulsion experimented with at 10° C. was examined immediately before the passage of chloroform vapour and air ; (*b*) the emulsions stored for 72 hours at 37° C., 30° C., 25° C., and 20° C. were examined after they had been kept for three hours at those temperatures ; and (*c*) the emulsions kept at 15° C. and 10° C. were examined after storage at those temperatures for 72 hours.

The following Table 3 shows the average of the results of the action of the chloroform on the extraneous micro-organisms of the five vaccine emulsions thus treated. The extraneous micro-organisms in each case consisted principally of *S. aureus* and *S. albus*, and regard was only paid to these varieties.

TABLE 3.

Average of Five Experiments with Vaccine Emulsion containing *S. aureus* and *S. albus*.

Time of Inoculating Nutrient Agar-agar and pouring plates.	Number of Micro-organisms present per platinum loopful of Emulsion at various temperatures.					
	10° C.	15° C.	20° C.	25° C.	30° C.	37° C.
Immediately before passage of air and chloroform vapour.	20,000	—	—	—	—	—
Three hours after passage of air and chloroform vapour had ceased.	—	—	300	14	4	0
Seventy-two hours after passage of air and chloroform vapour had ceased.	6,000	400	—	—	—	—

The germicidal action in this series of experiments approximates closely to the germicidal action demonstrated in the preceding series (Series 2), and the rate of germicidal action exerted by the chloroform process is shown to depend very intimately upon the temperature at which that process is carried out.

The emulsions of the present series of experiments, like the emulsions of the preceding series, were inoculated on calves at intervals of between three and four weeks after the passage through them of chloroform vapour and air. Until the time of inoculation the tubes of emulsion were left clamped in order to prevent any escape of chloroform, with the exception that each tube was opened once momentarily in order to remove a loopful of emulsion for the bacteriological examination.

The vesicles resulting from the inoculation of these emulsions on calves were similar in their respective values to the vesicles of Series 2. That is to say, the vesicles yielded by the emulsions stored (after chlorforming at 15° C.) in relation with chloroform at 10° C., 15° C., and 20° C. were of apparently the same value. In three cases out of the five, the emulsions chloroformed at 25° C. gave vesicles almost but not quite as good as those yielded by emulsions kept with chloroform at the three lower temperatures, while in the other two cases their vesicles were slightly but unmistakably poorer compared with the vesicles yielded by those emulsions kept with chloroform at the lower temperatures. The vesicles yielded by the emulsions kept with chloroform at 30° C. and 37° C. were of poorer quality than those resulting from the inoculation of emulsions chloroformed at lower temperatures.

It is evident, therefore, that the temperature at which vaccine emulsion is associated with chloroform is all important from

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point of view of destruction of extraneous micro-organisms, and equally important from the point of view of retention of full activity of the specific germ. It seems probable that when vaccine is required at the earliest moment after its collection from the calf, 20° C. is approximately the best temperature at which to eliminate its extraneous micro-organisms by means of the chloroform process. It will be shown later that vaccines which have been chloroformed at 20° C. have been quickly freed from their extraneous micro-organisms, and, after subsequent storage at 10° C. for several weeks, have retained a high degree of potency, their potency being always determined by their use for general vaccination purposes.

The Species of Micro-organisms killed by the Chloroform Process.

In a former paper* it was stated that the species of non-sporebearing extraneous micro-organisms usually found in crude calf vaccine at these laboratories were killed by the chloroform process in a few hours, while the potency of the vaccine was left in a high state of activity. During the past year experiments have been made to ascertain the effect of the chloroform process on species of micro-organisms other than those extraneous micro-organisms which have previously formed the subject of experiment. The majority of these additional species have never been found in vaccine at these laboratories; indeed, with the exception of *B. proteus vulgaris*, *coli communis*, and *streptococcus pyogenes* none of them have been so found.

The species of micro-organisms dealt with in the present experiments are *streptococcus pyogenes*, *B. proteus vulgaris*, *B. prodigiosus*, *B. pyocyaneus*, *B. fluorescens liquefaciens*, *B. typhosus*, *B. coli communis*, *B. diphtheriæ*, *B. mallei*, *B. tuberculosis*, *Spirillum choleræ Asiaticæ*, and *micrococcus miletensis*.

The experiments were made in two series:—

Series 1.

Beef broth emulsions of each of the foregoing species of micro-organisms were made. As soon as an emulsion was established, a suitable culture medium was inoculated with a small quantity of it and then incubated, in order to ascertain whether the micro-organism in question could be easily recovered from the emulsion. The emulsion was then divided into two equal parts, each of which was placed in one of the previously described chloroforming emulsion tubes. The tubes were themselves placed in a temperature of 20° C., and one of them subjected for six hours to the chloroform process in the manner already described; the second tube of emulsion not being brought into contact in any way with chloroform.

* Report of the Medical Officer, 1902-3.

Both parts of each emulsion were examined bacteriologically from time to time during the six hours; cultivations being made as a rule every hour from the beginning of the chloroform process. As a result it was found that the cultivations made from the beef broth emulsions through which chloroform vapour and air had been passed for six hours, in no case showed any sign of bacterial growth after suitable incubation; and that in many cases no growth resulted from these portions after they had been subjected to the chloroform process for a shorter period, three hours. The control portions of emulsion on the other hand, that is the portions not subjected to the chloroform process, gave rise to bacterial growth six hours after they had been placed at a temperature of 20° C. Thus the micro-organisms of the foregoing list were killed by being subjected to the chloroform process at 20° C.

Series 2.

In this series experiments were made on vaccine emulsion. The vaccine pulps collected for this purpose were used strictly for experimental purposes only and were not at any time associated with vaccine to be issued for general vaccination purposes. The emulsions were prepared by admixture of one part by weight of crude calf vaccine and two parts by weight of distilled water. To this emulsion the micro-organisms to be subjected to the chloroform process were added, and cultivations were at once made therefrom to ascertain whether recovery of the bacteria were possible. The emulsion was then divided into two equal parts, each part being placed in a chloroforming emulsion tube, and the steps of the process mentioned in the preceding series were followed *seriatim*.

In the present instance, as in the case of the broth emulsions, it was found that the bacteria added to the experimental emulsions were in every instance killed after subjection to the chloroform process at 20° C. for from three to six hours; whereas in the control emulsions at the end of this time—that is in the emulsions which had been placed at 20° C., but which had not been subjected to the influence of chloroform—the bacteria were found alive.

Immediately after subjection to the chloroform process for six hours, the chloroform was partially removed from the experimental emulsions and these, together with such control emulsions as contained non-pathogenic micro-organisms, were placed in the ice chest at 10° C.

One week after subjection to the chloroform process a portion of each experimental emulsion was inoculated on a calf, and at the same time portions of such control emulsions as contained non-pathogenic micro-organisms were similarly inoculated. An examination 120 hours later showed that the vesicles resulting from the experimental vaccine emulsions were indistinguishable from the vesicles of the controls.

It was found therefore that the micro-organisms enumerated at the beginning of these two series of [illegible] quickly

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killed by means of the chloroform process, and that further, no injury of potency was apparent in the vaccine emulsions from which they had been eliminated by this process.

The Preparation of Chloroformed Calf Vaccine and the Results of its Employment in Vaccination.

During the past year chloroformed calf vaccine has been issued from these laboratories at two separate periods of time after collection from the calf. The details of these two issues are as follows :—

Early Issue (Series A).

In the case of this series of vaccines, issue from the laboratory for general vaccination purposes was effected after the lapse of a short interval of time from collection of the pulp from the calf, namely, after an average interval of seventeen days. The crude pulp for these vaccines was collected from the calf in the usual manner and each vaccine was chloroformed on the day of its collection. The method of chloroforming was similar to that described on pp. 609–10. Some repetition may here be of service so that the preparation of chloroformed vaccine may be described in its entirety. The steps of the process were as follows :—

i. The pulp was weighed.

ii. The pulp was triturated with one and a half to twice its own weight of sterile distilled water until a sufficiently fine emulsion was produced.

iii. The emulsion was placed in the vaccine tube or tubes of the chloroform apparatus, and these tubes together with the rest of the apparatus were placed at a temperature of 20° C. for half an hour or more before beginning the passage of air and chloroform vapour through the emulsion. A Hearson's gelatine incubator was used as being of a convenient size to contain the apparatus and at the same time it enabled the process to be carried out at the required temperature in a room the temperature of which necessarily varied. An additional advantage of using the incubator lay in the non-exposure of the emulsion to light during the process, while the working of the apparatus could be inspected at any time through the glass door.

The apparatus consisted of a cotton wool air filter, a gas washing bottle partly filled with pure liquid chloroform, an overflow bottle for the chloroform, and a tube or tubes of test tube shape to contain the emulsion. The parts were connected by means of india-rubber tubing, as was the outlet of the emulsion tube with a filter pump in such a way that, the *exhaust* of the filter pump being used, air was drawn in the first instance through the cotton wool filter, next into the long tube of the gas washing bottle and through the liquid chloroform contained in it, whereby it became admixed with chloroform vapour. This mixture of

chloroform vapour and air was next drawn through the overflow bottle, and down the long tube of the emulsion tube, and so through the emulsion, passing through the short outlet of the emulsion tube to the filter pump. The rate of passage of air and chloroform vapour through the emulsion was regulated by means of a screw clamp placed on the india-rubber tubing attached to the outlet of the emulsion tube.

By such an arrangement of the apparatus in a compartment of constant temperature, such as a Hearson's incubator, it was possible to ensure that apparatus, emulsion, and the air and chloroform mixture passing through the emulsion, were maintained at the temperature required, namely 20° C. And as has been before stated, this temperature is probably the most suitable for the treatment of vaccine by the chloroform process.

Should the liquid chloroform not be of quite recent manufacture, or should it have been subjected to the prolonged action of daylight or to the prolonged passage through it of a current of air, it is of the utmost importance to ascertain by testing it chemically that it has undergone no decomposition, otherwise serious injury to the potency of the vaccine to be treated may result.

The emulsion having reached 20° C., the passage through it of the mixture of chloroform vapour and air was began and kept up for from two to six hours.

v. At the end of this time, the entrance and exit of each emulsion tube were clamped in order that none of the contained chloroform might escape, and the tube of emulsion was then placed in the ice chest at 10° C. The procedure so far was such as could be conducted during the hours of an ordinary working day. After being kept in the ice chest for from 15 to 24 hours the tube of emulsion was removed to the laboratory bench and sterile air was *forced* through it until no chloroform could be detected in the air issuing from the emulsion. The tube of emulsion was then replaced in the ice chest until the following day, when sterile air was again forced through it in order to remove any final traces of chloroform. A weighted quantity of pure glycerine was next added to the watery vaccine emulsion contained in the emulsion tube in the proportion of two parts by weight of glycerine to the original weight of vaccine pulp, and the intimate admixture of the glycerine and watery vaccine emulsion was effected by thoroughly agitating the emulsion tube. The tube of emulsion with the added glycerine was then replaced in the ice chest, where it remained until it was issued for general vaccination purposes after passing the usual tests.

The bacteriological examinations of the vaccines were made in the manner described in my last paper. Nutrient agar agar plates were established from tubes of liquefied agar which had been inoculated with one platinum loopful of the emulsion to be examined. These plates were incubated at 37° C. for 48 hours and subsequently at room temperature for 72 hours when the number and species of colonies grown were noted. Plates

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firstly, immediately before the subjection of the vaccine emulsion to the chloroform process, and again after being subjected to the chloroform process from 2 to 6 hours. A further plate was poured from each emulsion 18 to 24 hours later, and the last plate was poured about five days before issue of the vaccine for general vaccination purposes.

In every case where emulsions had been subjected to the process for 6 hours it was found that the extraneous bacteria—present just before the chloroforming generally in large numbers—had been eliminated. In a few cases where emulsions had been subjected to the process for 2 hours only, the extraneous bacteria were eliminated at the end of that time; and from the remaining emulsions subjected to the chloroform process for not more than 2 hours and then stored in the ice chest, the extraneous bacteria were eliminated in no case later than the end of the third day of storage. In the case of these emulsions the chloroform was not removed until the end of the third day when the extraneous bacteria were killed out.

Altogether, during the past year. 69 vaccine emulsions treated in the manner described, have, after passing the required tests, been issued for general vaccination purposes at an average interval of 17 days after collection from the calf. These vaccines have been employed for 65,735 vaccinations. The results of their use appear in the following Table 4.

TABLE 4.

Showing the results of the use of 69 chloroformed vaccines issued from the laboratory at an average interval of 17 days after their collection from the calf.

Chloroformed Vaccine used for—		Percentage Success.	
Kind of Vaccination.	No. of cases.	Case.	Insertion.
Primary Vaccinations	57,638	98·6	94·0
Re-vaccinations	8,097	98·0	94·6
Total	65,735	98·6	94·0

LATE ISSUE (SERIES B).

A further number of vaccines were treated in the manner described in Series A, with the exception that their issue for general vaccination purposes was delayed until the lapse of an average interval of nearly two months (54 days) from their collection from the calf

These vaccines were 15 in number and were used in the vaccination of 3,615 cases, with the results given in the following Table 5.

TABLE 5.

Showing the results of the use of 15 chloroformed vaccines issued from the laboratory at an average interval of 54 days after their collection from the calf.

Chloroformed Vaccine used for—.		Percentage Success.	
Kind of Vaccination.	No. of cases.	Case.	Insertion.
Primary Vaccinations	3,434	98·5	93·0
Re-vaccinations	181	95·5	92·3
Total	3,615	98·3	93·0

As was to be expected, these 15 vaccines issued from the laboratory at an average interval of nearly two months after their collection from the calf did not show such high percentage success as did the vaccines of Series A issued from the laboratory after an average interval of only 17 days. Nevertheless, these 15 vaccines must be regarded as having given high percentage success.

Thus, experience of the use of a considerable number of vaccines prepared by the chloroform process during the past year confirms the conclusions arrived at in my last paper. And the additional knowledge has been gained that chloroformed calf vaccine, if originally of sufficiently high potency, will retain potency in high degree for a considerable time, and this notwithstanding that the extraneous micro-organisms had been rapidly eliminated from it at an early stage. This additional knowledge is of importance in that it shows that chloroformed vaccine prepared in excess of the needs of the moment, would not, subject to the provisions above mentioned, become useless within a short time; that, on the contrary, it could be used successfully notwithstanding that several weeks had elapsed since its collection from the calf.

SUMMARY.

1. The optimum temperature for the preparation of vaccine by the chloroform process appears to be about 20° C.

2. The following bacteria, in addition to those mentioned in previous papers, are killed by the chloroform process at 20° C. in

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from three to eight hours:—*Streptococcus pyogenes*, *B. proteus vulgaris*, *B. prodigiosus*, *B. pyocyaneus*, *B. fluorescens liquefaciens*, *B. typhosus*, *B. coli communis*, *B. diphtheriæ*, *B. mallei*, *B. tuberculosis*, *Spirillum Choleræ Asiaticæ*, and *micrococcus melitensis*.

3. The issue of chloroformed vaccine for general vaccination purposes after an average interval of 17 days had elapsed since its collection from the calf has been attended with high "case" and "insertion" success. Sixty-nine vaccine emulsions used for 65,735 vaccinations gave primary "case" success 98·6 per cent., "insertion" success 94·0 per cent.; re-vaccination "case" success 98·0 per cent., "insertion" success 94·6 per cent.; total "case" success 98·6 per cent., "insertion" success 94·0 per cent.

4. The issue of chloroformed calf vaccine after an average interval of 54 days had elapsed since its collection from the calf has also been attended with high "case" and "insertion" success. Fifteen vaccine emulsions used for 3,615 vaccinations gave, primary "case" success 98·5 per cent., "insertion" success 93·0 per cent.; re-vaccination "case" success 95·5 per cent., "insertion" success 92·3 per cent.; total "case" success 98·3 per cent., "insertion" success 93·0 per cent.

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